तदेकोऽवशिष्टः शिवः केवलोऽहम् ।
I alone persist : Blissful : Absolute.

ॐ

सोऽहम् ।

Yoga-Mīmānsā

EDITED BY

S'RĪMAT KUVALAYĀNANDA

(J. G. Gune)

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KAIVALYADHĀMA

Post-Lonavla

(Bombay-India)

सर्वं खल्विदं ब्रह्म ।
All this is, indeed, Brahman.

नेह नानास्ति किञ्चन ।
There is nothing here apart from it.

शरीरमाद्यं खलु धर्मसाधनम् ।
Surely Health is the primary requisite of spiritual life.

Printed by D. R. Mitra at the Manoranjan Press, 3 Sandhurst Road, Bombay 4 & published by S'rīmat Kuvalayānanda (J. G. Gune), at Kun'javana (904 Valvana), Lonavla.

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सोऽहम् ।

YOGA-MĪMĀNSĀ

VOL. III JANUARY, 1928 NO. 1

Editorial Notes

MAY the Maker of all make this journal a success. Blessed is the name of the Lord. May He bless the workers of the Ās'rama with a happy and prosperous career as servants of the world which is only the Lord Himself objectified. May He, that has created us in His infinite wisdom, lead us to the light that is beyond all darkness.

* * *

WE have to offer our heart-felt thanks to our subscribers who in spite of our extreme irregularity in publishing the first two volumes, have continued to patronize our work. It is only with the kindness of such sympathetic patronage that we expect to continue our activity, and hope that in future we will be treated with the same consideration with which we have been treated upto now.

* * *

TO-DAY we wish to make a synthetic survey of the contents of the last two volumes and also have a peep at the ground to be covered in the third.

* * *

TAKING into consideration the Yogic exercises, so far as the poses are concerned, the technique of the most

important of these has been given. Ardhamatsyendra, Bhujaṅga, Dhanur, Hala, Matsya, Mayūra, Padma, Pas'chimatāna, Sarvāṅga, S'alabha, S'ava, S'īrsha, and Siddha, have been minutely described so far as their practice is concerned. Sarvāṅgāsana has been exhaustively dealt with in regard to its anatomy, physiology and therapeutics. Beautiful half-tone pictures illustrate not only everyone of these poses, but even their different stages. We propose, in the current volume, to treat S'īrshāsana in all its aspects and explain the technique of a few more Āsanas.

* * *

THE technique of all the chief Bandhas has also been described. Uḍḍiyāna has been studied very exhaustively, whereas Jālandhara and Mūla have been treated from the practical point of view. In this issue we have explained the exercise of Jihvā-Bandha and hope to discuss very interesting aspects of all the four Bandhas in connection with Prāṇāyāma in this and the next volume. Uḍḍiyāna has been subjected to a searching inquiry through X-Rays and the barometer, and has yielded much information clearing the physiology of Yoga. The experiments given in this issue and those that will be given in the subsequent ones, are likely to add to our present day knowledge of the actions of the diaphragm and the intercostal muscles.

* * *

OUT of the two Mudrās referred to in the first two volumes, Yoga-Mudrā has been treated at some length. Not only its technique has been given, but also its use as a replacing exercise has been noted. As'vinī has only been casually noticed. In this volume we wish to detail its technique.

* * *

OUT of the six Kriyās known in Haṭha Yoga, Nauli and Basti have been studied in detail. Like Uḍḍiyāna

these have been experimented upon and have yielded very interesting information of great physiological and therapeutical value. A lengthy article has appeared on Dhauti taking notice of its physiology. Therapeutical importance of this Kriyā is yet to be discussed. We hope to do this in the current volume. We also wish to treat in this volume a fourth Kriyā called Kapālabhāti. It is a breathing exercise of unique value.

* * *

TWO very important exercises are to be dealt with this volume. They are Viparīta Karaṇī and Gaja-Karaṇī. Out of these the first has been described in this issue from the practical point of view. The second will be taken up either in the next or the third issue of this volume.

* * *

BUT by far the most important exercises we wish to describe and discuss in this and the subsequent volumes, are the exercises in Yogic breathing called Prāṇāyāma. These exercises are the master-pieces of the ancient Yogic savants and are of supreme value to the physical as well as to the spiritual culturist. But they have been very seriously misrepresented in the West; and we in India who are bent upon blindly following the Western lead, are being misguided for these misrepresentations. So a large amount of work has to be done in clearing the ground, before we can approach the subject proper. There is again another difficulty. We have to examine and see whether the actions of the most important respiratory muscles such as the diaphragm and the intercostals, have been correctly understood by the modern anatomist and physiologist. All this requires much careful consideration and discussion and is likely to occupy considerable space in this volume. A lengthy article on this subject appears in the Scientific Section of this issue. We have to request our readers to realise the importance of this in understanding the problem of Prāṇāyāma properly. We do propose to give detailed

instruction in Prāṇāyāma from the third number of this volume.

* * *

PREVENTION is always better than cure. Yogic exercises have a great curative value. But their preventive value is far greater than their curative value.

* * *

THESE preventive exercises in Yoga constitute what we call *the Yogic system of physical culture.* A very closely reasoned article on this subject has appeared in this and the last two issues and will be concluded in the next number. It not only discusses the physiological basis of the Yogic system of physical culture, but also introduces incidental comparisons between this system and some of the systems of the West, and tries to determine their comparative worth. A study of this article is essential for everyone who wants to understand with what wonderful physiological accuracy the Yogic seers formulated their system.

* * *

A VERY carefully arranged scheme of Yogic exercises has also been given for the average men of health. We have already received information that this scheme has been found extremely useful by Yogic physical culturists.

* * *

THE therapeutical researches published in the last two volumes have been welcomed everywhere with great enthusiasm. Our Clinical Laboratory and Health Resort have become the most attractive features of our Ās'rama. Patients even from far off provinces of our country come for Yogic treatment and find relief.

* * *

THE diseases elaborately treated in the last two volumes are auto-intoxication, seminal weakness, constipation, appendicitis, thyroid degeneration, and epilepsy. Treat-

ment for leprosy and the degenerated testes, ovaries, liver, spleen etc. has also been casually mentioned. In this volume we propose to discuss the Yogic treatment of dyspepsia at full length ; and if space allows, would take up the Yogic therapeutics of nervous debility, piles and tonsilitis.

* * *

EXHAUSTIVE notes, written in the most popular style, have appeared in the last two volumes on different physiological subjects. The digestive system, the circulatory system and the glandular system have been treated at length, from both the anatomical and physiological points of view. The muscular and the nervous systems are also described, though not in great detail. A very clear and concise note has also appeared on blood pressure. In the present volume we wish to treat the respiratory system at some length.

* * *

THE experimental work published in the last two volumes has been as interesting as it is conclusive. Our laboratory evidence is clearing many misunderstandings about Yogic culture and is proving the wonderful scientific insight the Yogic savants showed in developing their science and art. The experiments to be published in the third volume are of still greater interest and are likely to throw new light on one or two anatomical and physiological problems of the present day.

* * *

EVERY topic discussed in these pages has always been made quite intelligible to our readers by means of vivid illustrations.[1]

* * *

1 Either in explaining the technique of a particular exercise or in treating a physiological function or in describing an anatomical structure, there has not been a single point where an illustration was needed and has not been given. Our original plan was to give only sixty-four illustrations in each volume. But in the first volume we have given as many as a hundred and in the second a few more than in the first. Even in the work that is to follow, we do not wish to stint in this connection.

THREE indexes of the contents, illustrations and general topics appearing in the first two volumes, have been added at the end of the second volume. As these are quite exhaustive and as usual alphabetically arranged, they should enable our readers to find any reference with utmost ease.

* * *

THIS elaborate survey of the past and this peep into the future, will enable our readers to see that we have already covered a considerable portion of Yogic exercises and that whatever we have done has been accomplished with the necessary thoroughness. The literature that has been published upto now is of supreme value to every student of Yoga, whether his interest in the subject is practical or theoratical.

* * *

MAY we then request our readers graciously to pardon us for our drawbacks from which no human work can be free and which we know we have in abundance? Are we not also justified in requesting every reader of this journal to help us, as best as he can, in doing our work? Those that can do nothing else, may they not be expected to pray to the Lord to bless our Ās'rama and its inmates, enabling them selflessly to serve humanity to the best of their ability?

* * *

WE strongly hope that our readers will answer all these questions in the affirmative and will receive this volume with the same love and appreciation with which they received the first two.

The Scientific Section

SYSTEM OF TRANSLITERATION

Letters, their sounds and a description of these sounds :—

अ	A	Pronounce	'A'	like	'u'	in	'but'.
आ	Ā	„	'Ā'	„	'a'	„	'far'.
इ	I	„	'I'	„	'i'	„	'pin'.
ई	Ī	„	'Ī'	„	'ee'	„	'feel'.
उ	U	„	'U'	„	'u'	„	'fulsome'.
ऊ	Ū	„	'Ū'	„	'oo'	„	'wool'.
ऋ	Ṛi	„	'Ṛi'	„	'rö'	„	German.
ॠ	Ṝī	„	'Ṝī'	„	„	„	„ with a strong accent.
ऌ	Ḷi	„	'Ḷi'	„	'lö'	„	German.
ए	E	„	'E'	„	'a'	„	'fate'.
ऐ	AI	„	'AI'	„	'ai'	„	'aisle' but not drawled out.
ओ	O	„	'O'	„	'o'	„	'over'.
औ	AU	„	'AU'	„	'ou'	„	'ounce' but not drawled out.
क	KA	„	'K'	„	'k'	„	'kill'.
ख	KHA	„	'KH'	„	'kh'	„	'ink-horn' or like 'ch' in 'Loch' (Scottish).
ग	GA	„	'G'	„	'g'	„	'girl'.
घ	GHA	„	'GH'	„	'gh'	„	'log-house' or 'ghee'.
ङ	N̄A	„	'N̄'	„	'n'	„	'king' or 'link'.
च	CHA	„	'CH'	„	'ch'	„	'church'.
छ	CHHA	„	'CHH'	„	the second 'ch' in 'churchill'.		
ज	JA	„	'J'	„	'j'	in	'join'.
झ	JHA	„	'JH'	„	palatal 'z' as in 'azure'.		
ञ	N'A	„	'N''	„	'n'	in	'pinch'.
ट	ṬA	„	'Ṭ'	„	't'	„	'tub'.
ठ	ṬHA	„	'ṬH'	„	'th'	„	'pot-house'.

Letters, their sounds and a description of these sounds:—

ड	DA	Pronounce	‘D’	like	‘d’	in	‘dog’.
ढ	ḊHA	,,	‘ḊH’	,,	‘dh’	,,	‘madhouse’.
ण	ṄA	,,	‘Ṅ’	,,	‘n’	,,	‘splinter’ or ‘and’.
त	ṪA	,,	‘Ṫ’	like dental ‘t’ as in ‘thin’, or like the French ‘T’.			
थ	THA	,,	‘TH’	,,	‘th’	in	‘thunder’.
द	DA	,,	‘D’	,,	‘th’	,,	‘then’.
ध	DHA	,,	‘DH’	,,	‘th’	,,	‘this’.
न	NA	,,	‘N’	,,	‘n’	,,	‘no’.
प	PA	,,	‘P’	,,	‘p’	,,	‘paw’.
फ	PHA	,,	‘PH’	,,	‘ph’	,,	‘top-heavy’, or ‘gh’ in ‘laugh’.
ब	BA	,,	‘B’	,,	‘b’	,,	‘balm’.
भ	BHA	,,	‘BH’	,,	‘bh’	,,	‘hob-house’.
म	MA	,,	‘M’	,,	‘m’	,,	‘mat’.
य	YA	,,	‘Y’	,,	‘y’	,,	‘yawn’.
र	RA	,,	‘R’	,,	‘r’	,,	‘rub’.
ल	LA	,,	‘L’	,,	‘l’	,,	‘lo’.
व	VA	,,	‘V’	,,	‘w’	,,	‘wane’.
श	S′A	,,	‘S′’	,,	‘sh’	,,	‘ashes’.
ष	SHA	,,	‘SH’	,,	a strong lingual with rounded lips.		
स	SA	,,	‘S’	,,	‘s’	in	‘sun’.
ह	HA	,,	‘H’	,,	‘h’	,,	‘hum’.
ळ	ḶA	A dento-lingual pronounced with a little rounding of lips.					

Visarga—Ḥ; Nasalized म् as in संयम—ṁ;

Nasalized न् as in मीमांसा—ṅ.

Y. 2

EXPERIMENTS ON INTRA-GASTRIC PRESSURE

General features of first four experiments

In the X-Ray experiments on Dhauti published in the third number of the second volume of this journal, it was observed that in Uḍḍiyāna although the upper end of the stomach almost touched the diaphragm, the stomach as a whole remained far below this roof of the abdomen. We have reproduced here Figs. LXXXIV-LXXXVa of the second volume as Figs. XIV-XVII respectively. Out of these the latter two figures represent the relative position of the diaphragm and the stomach during Uḍḍiyāna, the first two showing their normal positions. Here Fig. XVI clearly indicates the broad space left between the diaphragm and the stomach.

These observations lead to the following conclusions—

i In Uḍḍiyāna the stomach rises very high, indeed, being pushed up by the intestines; but the diaphragm rises higher still.

ii Therefore the rise of the diaphragm is independent of the rise of the stomach.[1]

iii Also therefore the stomach becomes free from the normal pressure of the diaphragm.

iv Hence the normal intra-gastric pressure must decrease in Uḍḍiyāna.

These conclusions would be corroborated, if the last statement found additional experimental evidence to support its truth. It was in search of this sort of evidence that the following experiments were tried.

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1 A detailed discussion on this point will be found in this issue in our article 'The Diaphragm and the Ribs'.

Already Mr. P. B. Ganu, M. Sc., an Ās'ramite brother, had brought to our notice that he had observed a sort of negative pressure being created in the stomach during Uḍḍiyāna. So what remained for us now was to know the exact measure of the decrease in the intra-gastric pressure. This was done, as the experiments will show, by measuring the fall of a mercurial column in a rectangular-shaped glass tube connected with the stomach by means of an India-rubber tube passed through the throat.

Along with Uḍḍiyāna experiments were tried also in Nauli.

Three subjects were put under observation for Uḍḍiyāna and Nauli. All of them were youths of sound health, well established in the practice of these exercises. In the case of every subject three readings were taken for the same position and an average was worked out to indicate the correct reading of that subject for the particular exercise. Again an average of these three averages was calculated so that the result indicated the average decrease in the intra-gastric pressure in general for the particular Yogic practice.

As the results showed, Nauli in all its aspects secured a larger decrease in the intra-gastric pressure than Uḍḍiyāna. The full significance of these experiments will be clear when we discuss the question of Prāṇāyāma with reference to the movements of the diaphragm.

EXPERIMENTS ON INTRA-GASTRIC PRESSURE

Experiment I

OBJECTS OF THE EXPERIMENT :—

It was incidentally observed during the X-Ray experiments on Uḍḍiyāna that in this practice the diaphragm was raised far above the stomach and thus relieved the latter of its pressure in the abdominal cavity. It was inferred that this circumstance must be leading to a decrease in the intra-gastric pressure during Uḍḍiyāna. This experiment was undertaken to ascertain whether there was any decrease at all and in case it was there, to know the exact measure of the decrease.

PREPARATION OF THE SUBJECTS :—

Three subjects were tried in this experiment. They were youths of ages ranging between 23 and 29, and were well established in the practice of Uḍḍiyāna, the same being undergone by them as a daily routine. Their health was normal being usually of a sound constitution. At 12 noon on the day previous to the experiment, they had had their usual meal. They retired without any food in the evening, slept well over night and had a clear motion in the morning. Their stomach and bowels were light at the time of the experiment which was done at about 9 a. m.

THE APPARATUS :—

The apparatus was simple. A rectangular glass tube, 34 cm. in height was half filled with mercury, both of its ends being free. It was firmly fixed perpendicular upon a stand and a measuring scale marked with mm. was fitted to one of its arms. The other arm was connected with an India-rubber tube long enough to leave some 12 inches

outside the mouth, after reaching the stomach of the sub jects when introduced through the throat. This much length is necessary to allow the subjects to have free movements in Uḍḍiyāna, howsoever small they may be.

THE EXPERIMENT PROPER :—

The subjects were tried in succession, each one going through the same process. They first introduced the rubber tube into their stomach through the throat. The mercury did not show either any fall or rise when the tube had reached the stomach, indicating thereby that the normal intra-gastric pressure was perhaps equal to the atmospheric pressure. Uḍḍiyāna was then practised by each of them thrice, every time a couple of minutes being allowed to go by between two successive attempts. The column of mercury invariably fell during all the actions of Uḍḍiyāna, and conclusively proved that the intra-gastric pressure decreased during the practice of the exercise. The particular measure of decrease during every attempt on the part of the three subjects has been shown in the following table.

Subjects	1st attempt	2nd attempt	3rd attempt	Average
A	28 mm.	18 mm.	29 mm.	25 mm.
B	29 mm.	30 mm.	28 mm.	29 mm.
C	29 mm.	29 mm.	28 mm.	28·7 mm.

If we put together the three averages of the three subjects and divide the sum by three, we get 27·6 mm. which shows the average decrease in the intra-gastric pressure in general.

Thus the experiment gives convincing evidence supporting the inference drawn in X-Ray experiments, namely, Uḍḍiyana decreases the intra-gastric pressure by raising the diaphragm far higher than the stomach.

EXPERIMENT II

OBJECTS OF THE EXPERIMENT :—

The objects of the experiment were to know whether the intra-gastric pressure decreased during Nauli-Madhyama or the central aspect of Nauli ; and if it did, to know the exact measure of the decrease effected.

PREPARATION OF THE SUBJECTS :—

The same subjects were tried in this experiment as in the last, immediately after that experiment.

THE APPARATUS :—

The apparatus used in the last experiment was also used here.

THE EXPERIMENT PROPER :—

Instead of Uḍḍiyāna, the subjects practised Nauli-Madhyama and the readings were taken. Otherwise the procedure was exactly the same as in the last experiment. The results are tabulated below with their averages.

Subjects	1st attempt	2nd attempt	3rd attempt	Average
A	39 mm.	49 mm.	41 mm.	43 mm.
B	39 mm.	44 mm.	39 mm.	40·7 mm.
C	39 mm.	39 mm.	38 mm.	38·7 mm.

Here the final average is found to be 40·8 mm. It will be noted that the decrease in the intra-gastric pressure secured in Nauli-Madhyama is greater than that obtained in Uḍḍiyāna.

EXPERIMENT III

OBJECTS OF THE EXPERIMENT:—

The objects of the experiment were to know whether the intra-gastric pressure decreased during Vāma Nauli or the left aspect of Nauli; and if it did, to know the exact measure of the decrease effected.

PREPARATION OF THE SUBJECTS:—

The same subjects were tried in this experiment as in the last, immediately after that experiment.

THE APPARATUS:—

The apparatus used in the last experiment was also used here.

THE EXPERIMENT PROPER:—

Instead of Nauli-Madhyama, the subjects practised Vāma Nauli and the readings were taken. Otherwise the procedure was exactly the same as in the last experiment. The results are tabulated below with their averages.

Subjects	1st attempt	2nd attempt	3rd attempt	Average
A	39 mm.	34 mm.	49 mm.	40·7 mm.
B	39 mm.	41 mm.	41 mm.	40·3 mm.
C	38 mm.	38 mm.	36 mm.	37·3 mm.

Here the final average is found to be 39·4 mm. It will be noted that the decrease in the intra-gastric pressure secured in Vāma Nauli is greater than that obtained in Uḍḍiyāna; but approximately the same as available in Nauli-Madhyama.

EXPERIMENT IV

OBJECTS OF THE EXPERIMENT:—

The objects of the experiment were to know whether the intra-gastric pressure decreased during Dakshiṇa Nauli or the right aspect of Nauli; and if it did, to know the exact measure of the decrease effected.

PREPARATION OF THE SUBJECTS:—

The same subjects were tried in this experiment as in the last, immediately after that experiment.

THE APPARATUS:—

The apparatus used in the last experiment was also used here.

THE EXPERIMENT PROPER:—

Instead of Vāma Nauli, the subjects practised Dakshiṇa Nauli and the readings were taken. Otherwise the procedure was exactly the same as in the last experiment. The results are tabulated below with their averages.

Subjects	1st attempt	2nd attempt	3rd attempt	Average
A	39 mm.	49 mm.	34 mm.	40·7 mm.
B	39 mm.	37 mm.	37 mm.	37·7 mm.
C	37 mm.	40 mm.	36 mm.	37·7 mm.

Here the final average is found to be 38·7 mm. It will be noted that the decrease in the intra-gastric pressure secured in Dakshiṇa Nauli is greater than that obtained in Uḍḍiyāna; but approximately the same as available in Nauli-Madhyama and Vāma Nauli.

EXPERIMENT V

OBJECTS OF THE EXPERIMENT :—

The objects of the experiment were to know whether the intra-gastric pressure increased or decreased during forced expiration; and if it increased or decreased, to know the exact measure of the change.

PREPARATION OF THE SUBJECTS :—

The same subjects were tried in this experiment as in the last. But this experiment was done on a different day, although their preparation was the same as previously.

THE APPARATUS :—

The apparatus used in the last experiment was also used here.

THE EXPERIMENT PROPER :—

Intra-gastric pressure was recorded in the case of every subject while he was very gently breathing. Afterwards he was made to exhale completely and then to keep the abdominal muscles contracted along with the chest. It was found that the column of mercury stood higher during this condition. The increase was thrice measured in the case of every subject and an average taken. The final average obtained from these averages is 7·33 mm., and may be taken to represent the average increase in the intra-gastric pressure in forced expiration.

Subjects	1st attempt	2nd attempt	3rd attempt	Average
A	10 mm.	7 mm.	7 mm.	8 mm.
B	6 mm.	5 mm.	4 mm.	5 mm.
C	10 mm.	8 mm.	9 mm.	9 mm.

THE DIAPHRAGM AND THE RIBS

PART I

CAN WE RAISE ONE WITHOUT LOWERING THE OTHER?

[1]THE actions of the diaphragm have long formed an object of controversy in the medical world. During respiration this muscle rises and falls. The other organs involved in this controversy are the ribs. They also rise and sink during respiration. Among many other points two were mainly at issue. One was the nature of the actions of the diaphragm itself, and the other was the relation between the actions of the diaphragm and the rising of the ribs. Regarding the first point before the researches of Dr. Halls Dally which are now looked upon as authoritative by the medical world, scientists were of opinion that during inspiration the central tendon of the diaphragm remained fixed, while the domes flattened in descent. Dr. Halls Dally by his prolonged investigation of the subject of respiration, proved that during inspiration the curvature of the diaphragm is scarcely altered, the dome along with the tendon moving downwards nearly parallel to its original position, no fiattening being present.

Although Dr. Halls Dally entirely differed from his predecessors in regard to the movements of the diaphragm itself, he partly upheld their theory about the relation existing between the actions of the diaphragm and the rising of the ribs, the second point at issue. Old scientists were of opinion that the diaphragm was entirely responsible for raising the ribs during inspiration ; whereas Dr. Halls Dally has come to the conclusion that in raising the ribs the diaphragm is also assisted by the external intercostals.

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1 Although the article is included in the Scientific Section, non-medical readers will be able to follow it, provided they have carefully read this journal thus far. The opening paragraphs may present some difficulty ; but they too will be clear when the reader grasps the details that follow.

Thus we find that medical scientists have always held the diaphragm either entirely or partly responsible for raising the ribs.[1] But Mr. J. P. Muller, a physical culturist of the West, has come forward to challange the scientists including Dr. Halls Dally whose researches he admires. This physical culturist is of opinion that the diaphragm is too weak an organ to raise the ribs. He holds that it is the ribs that move the diaphragm.

The medical world looks to have let the physical culturist alone, so far as his theory is concerned. For in spite of the challange thrown out before years, standard books discussing the physiology of the diaphragm do not as yet say that the ribs are responsible for the movement of the diaphragm.

We want to see in this article whether we can throw any light on this controversy, by examining the problem with the help of X-Ray and other experiments that we have been doing in our Yogic research.

In order to enable our readers to follow our argument clearly, it is desirable not only to state in detail the problem of which we have given above only a bare outline, but also to notice a few facts about the mechanism of respiration.[2] We shall first study the anatomy of the organs with which we are directly concerned here.

We start with the diaphragm. As we have often noticed in the pages of this journal, this is a big dome-shaped muscle, dividing the thorax from the abdomen. Its convex upper surface is towards the thorax and the concave under surface covers the abdomen. Thus the muscle at once forms the floor of the thorax and the roof of the abdomen. The dome of the diaphragm differs from the ordinary

1 We know that there are some scientists who make no reference to the diaphragm in discussing the question of the rising of the ribs. We shall consider the points of agreement and disagreement between these scientists and ourselves, at the end of this article.

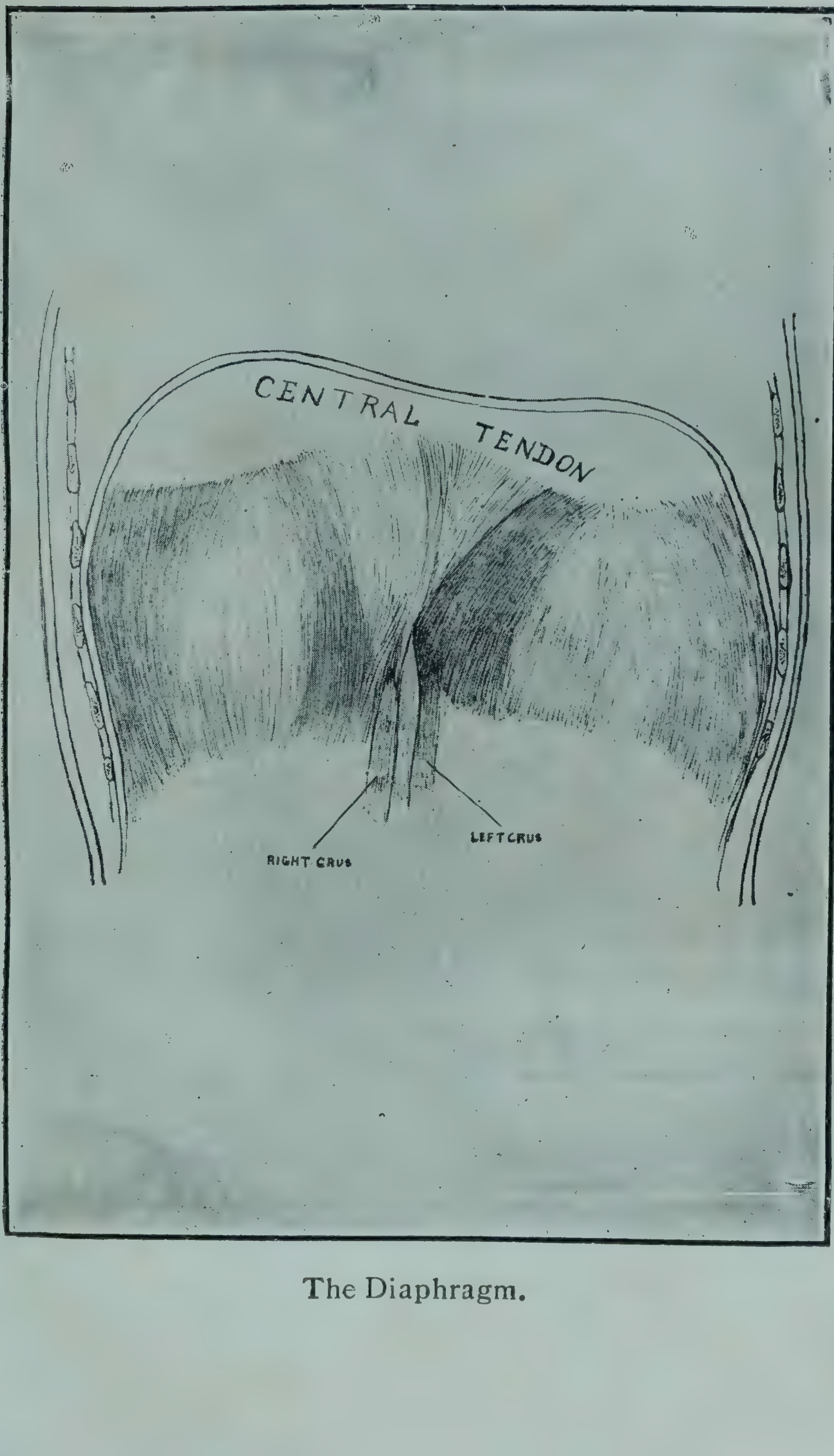
2 For the non-medical readers of our journal, a detailed 'Note on Respiration' will appear in the next issue. The information given here will, however, enable them to follow the logic of this article.

domes in having two summits instead of one only. These summits form the right and left portions of the diaphragm with a slight depression in the middle. A reference to Fig. I will show that the right summit is a little higher in level than the left. Although the diaphragm is in general a muscle, it has a band of dense fibrous tissues crossing the dome at the top from side to side in front of the spine. As this forms the central part of the organ it is known as the *central tendon.* (See Fig. I). The slopes and the borders of the diaphragm are composed of muscular fibres which arise from the thorax making an oblique angle with the ribs and converge upwards to be inserted into the central tendon. Along with this muscular tissue there are two strong fibrous bands which connect the diaphragm with the vertebral column. They are called *crura*, the right one, the *right crus* and the left one, the *left crus.* Fig. I illustrates the back half of the diaphragm as seen from the front. The diaphragm is supplied by the phrenic nerve.

Next we consider the ribs. They are elastic arches of bone, twelve on each side of the thorax. In Fig. II they have been marked with English figures. All of them start from the vertebral column, but the first five only join the breastbone by means of separate cartilages. The sixth and seventh also do the same, but have their cartilages joined together. The eighth, ninth and tenth have their cartilages fused together, and are connected with the breastbone through the cartilage of the seventh rib. The last two ribs end in the wall of the abdomen. In this way the higher five are independent of one another, whereas the lower five are connected mutually by means of joints with their cartilages. In the accompanying illustration, the cartilages have been marked with dots.

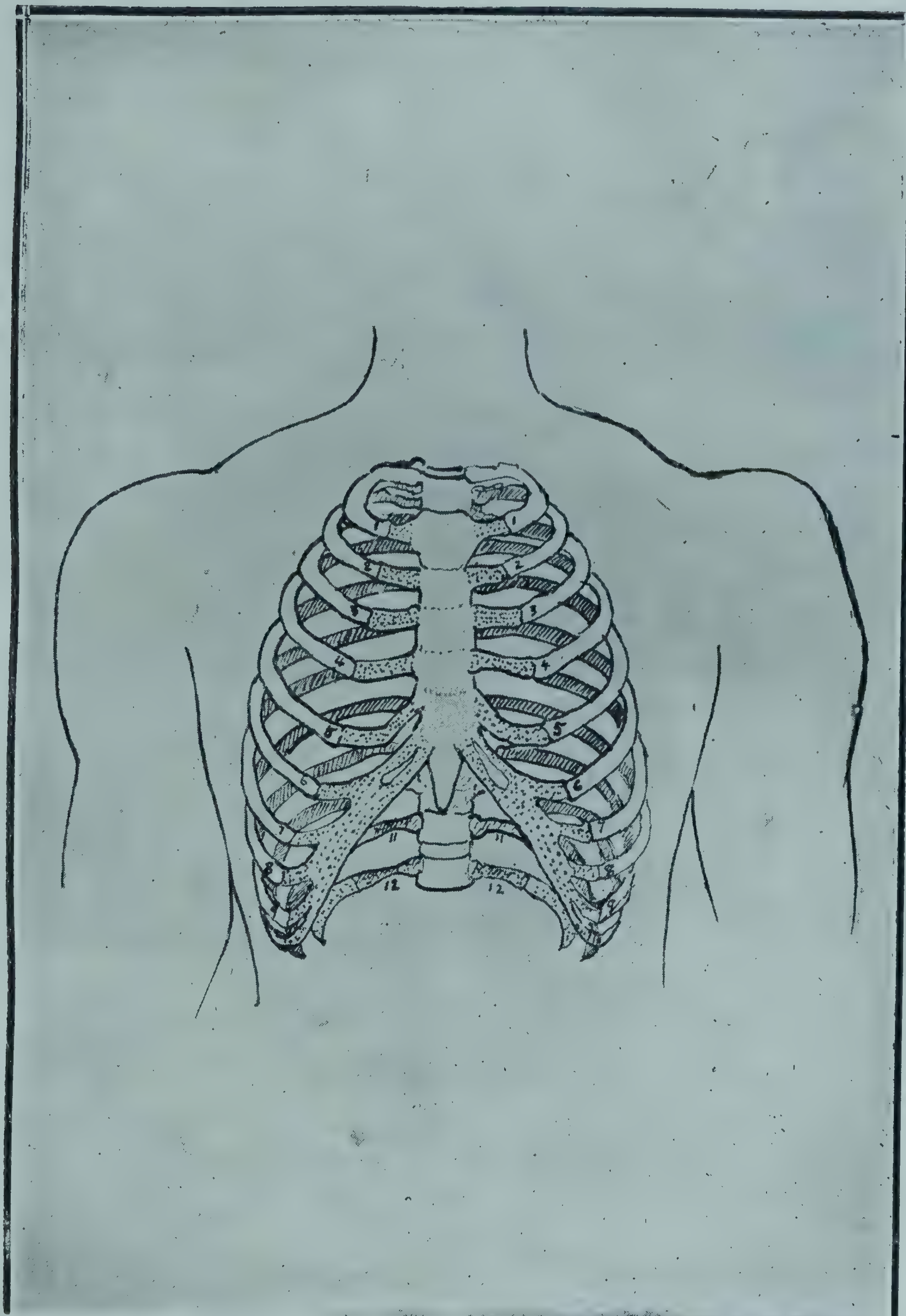
Next we go to intercostal muscles, that is, muscles which occupy the spaces between any two successive ribs. Twelve ribs have eleven intermediate spaces and hence we have as many intercostal muscles. Each intercostal consists of two

Fig. 1



The Diaphragm.

Fig. II



The Ribs.

(The Cartilages have been marked with dots)

thin plates of muscular and tendinous fibres. The inner plates are known as *internal intercostals* and the outer ones as *external intercostals*. Portions that are situated between two cartilages are said to be *intercartilaginous* Although we are not directly concerned with the abdomen, we may notice one or two facts about it. The abdomen is surrounded by a strong muscular wall. The different viscera contained in the abdomen are held together by this strong muscular wall and are covered by the diaphragm from above.

Having noticed these anatomical facts we now proceed to examine the question at issue in detail.

The first question, as stated above, refers to the actions of the diaphragm itself. We have already seen that the predecessors of Dr. Halls Dally held a view which has been refuted by the latter and that Dr. Halls Dally's view has now been accepted by the medical men. We quote Dr. Halls Dally's criticism on the movement of the diaphragm as given by Mr. Muller from the former's lecture *Respiration in Health and Disease*.

'For any adequate description of this movement you will consult in vain most of the standard works on physiology. Until the present date most of these works state that during inspiration the central tendon of the diaphragm remains fixed, while the domes flatten in descent, this supposed action being illustrated in many cases by imaginative diagrams. In point of fact no such action takes place It is true that on orthodiagraphic examination in subjects with well-developed diaphragmatic descent, a slight depression is sometimes seen just external to the summit of the right dome, this being due to the strong downward pull of the right crus; and that in some people with marked raising of the lower ribs the convexity of the dome represents the arc of a slightly larger circle than it does in expiration; but with these minor exceptions, which I only mention for

the sake of completeness, it is incorrect to state that any flattening of the domes occurs. As I pointed out in 1903, the curve of the convexity on each side is unaltered in descent, and each half—although attached to its fellow of the opposite side by the central tendon—by means of its own separate innervation through the phrenic nerve, acts quite independently. . . . "[1]

Having thus stated his view of the movements of the diaphragm itself, which, as noted in the beginning forms the first point of controversy. Dr. Halls Dally proceeds to make clear the relation between the actions of the diaphragm and the actions of the ribs. This is the second and the most important point at issue. The Doctor says—

'This second movement (a raising and lateral movement of the lower set of ribs) is also caused by the diaphragm, which, having by this time descended until its central tendon exerts firm continuous pressure upon the intra-abdominal viscera, now executes the second part of its dual action in contracting its ring of costal fibres. These, being attached at an oblique angle to the ribs, in contraction raise the ribs upwards and outwards, being aided by the external intercostals and intercartilaginous portions of the internal intercostals.'[1]

In this statement two conclusions have been reached.

i The principal agency responsible for lifting the ribs in inspiration is the diaphragm which accomplishes this work by the contraction of its peripheral muscle fibres.

ii The intercostal muscles play only a subordinate part in raising the ribs during inhalation. Their action, however, though subordinate, is definite.

These conclusions of Dr. Halls Dally, it seems, have not met with universal acceptance in the scientific world.

1 J. P. Muller's *My Breathing System*, p. 35.

Some authorities do follow him, indeed. But there are others who still differ from him, and do not allow any share to the intercostal muscles in raising the ribs during inspiration. We quote two passages from Gray's *Anatomy* in support of what we say. In discussing the actions of the diaphragm the author says—

"In this movement the curvature of the Diaphragm is scarcely altered, the dome moving downwards nearly parallel to its original position and pushing before it the abdominal viscera. The descent of the abdominal viscera is permitted by the extensibility of the abdominal wall, but the limit of this is soon reached. The central tendon applied to the abdominal viscera then becomes a fixed point for the action of the Diaphragm, the effect of which is to elevate the lower ribs and through them to push forwards the body of the sternum and the upper ribs."

In this statement no mention has been made of the assistance given by the intercostal muscles to the diaphragm in raising the ribs.

So also in describing the actions of the intercostal muscles themselves, the author clearly says—

"The intercostales externi et interni have probably little action in moving the ribs. They contract simultaneously and form strong elastic supports which prevent the intercostal spaces being drawn in or bulged out during respiration."

Although there is thus a radical difference of opinion among the present day scientists regarding the actions of the intercostal muscles, there is only a little difference among them regarding the actions of the diaphragm which is admitted by all as the prime mover of the ribs during inspiration.[1]

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1 Read our foot-note on p. 19 marked with 1.

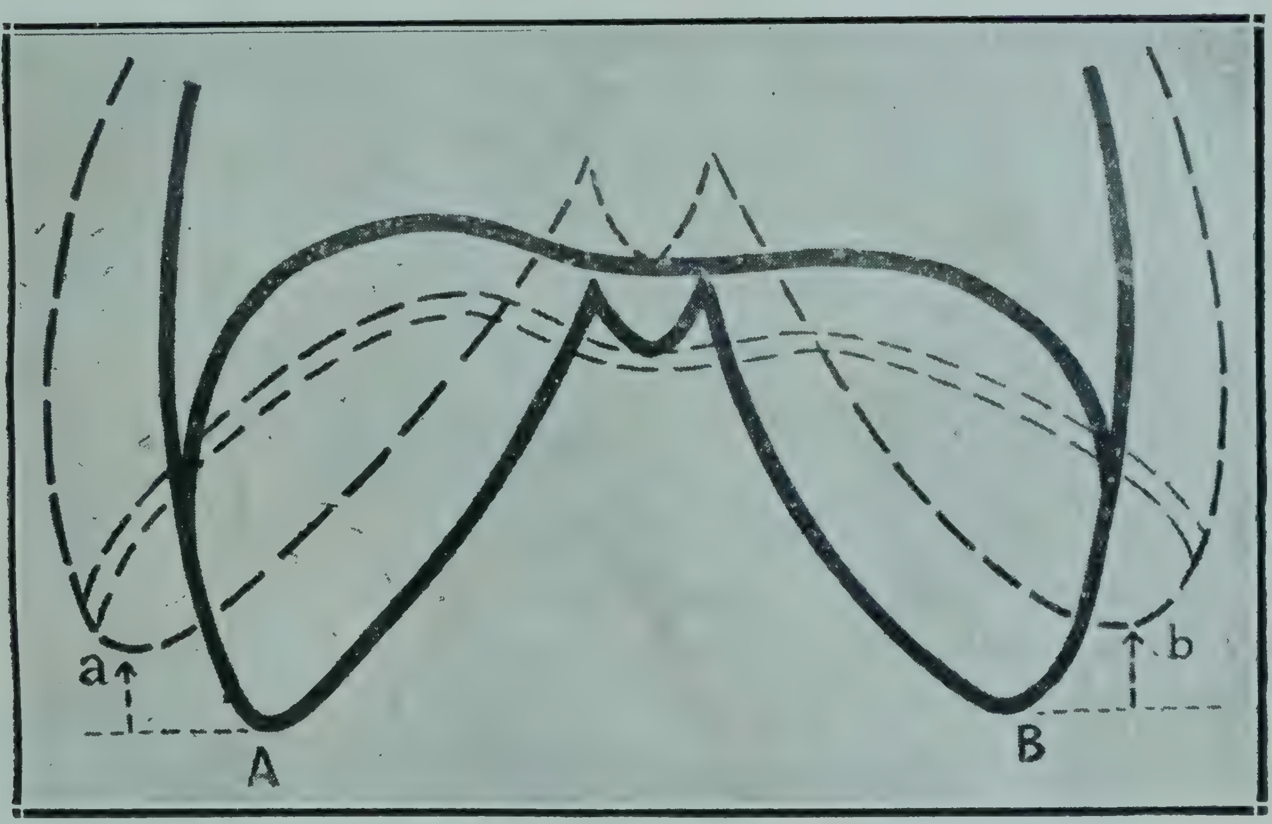
Now, in this connection, Mr. J. P. Muller, the physical culturist, has taken his stand against the whole medical world. We quote *in extenso* from his book *My Breathing System.* After referring to the views of the old anatomists and to the findings of Dr. Halls Dally, Mr. Muller proceeds to give his own theories about the diaphragm saying—

"When we breathe very quietly—for instance, when resting or sleeping—the diaphragm 'pulsates' on its own account, and that quite unconsciously, in a manner similar to the beating of the heart. In this case the slight contractions and relaxations of the diaphragm form, in many persons, almost the only motive power of their breathing. But when more change of air is needed, part or the whole of the thorax expands and contracts, moved by muscles which, in well-developed individuals, are much stronger than the diaphragm. Even if it still continue its own small 'pulsations', the diaphragm is now, as a whole, forced to give way to the movements of the lower ribs and sternum, to which it is attached. It will be easily understood that, when the ribs are brought nearer to each other, the whole middle part of the diaphragm will move upwards; and when the ribs are moved away from each other, this central portion of the diaphragm will sink, even though the ribs are at the same time somewhat raised. It is only the outer annular border or margin of the diaphragm which is brought into a nearly vertical position when the ribs are contracted, and into an almost horizontal position when the ribs are expanded and raised, whilst the central part, including the domes, will move up and down without materially altering its shape. The skeleton-like Fig. 9[1] shows these movements. When the points *A* and *B* of the ribs move outwards and upwards to *a* and *b* respectively, the domes will sink, but are quite able to keep their shape."

Again

1 This figure has been reproduced here as Fig. III.

Fig. III



Skeleton-like Illustration of the way in which the Ribs move the Diaphragm, according to Mr. Muller's theory.

Fig. IV



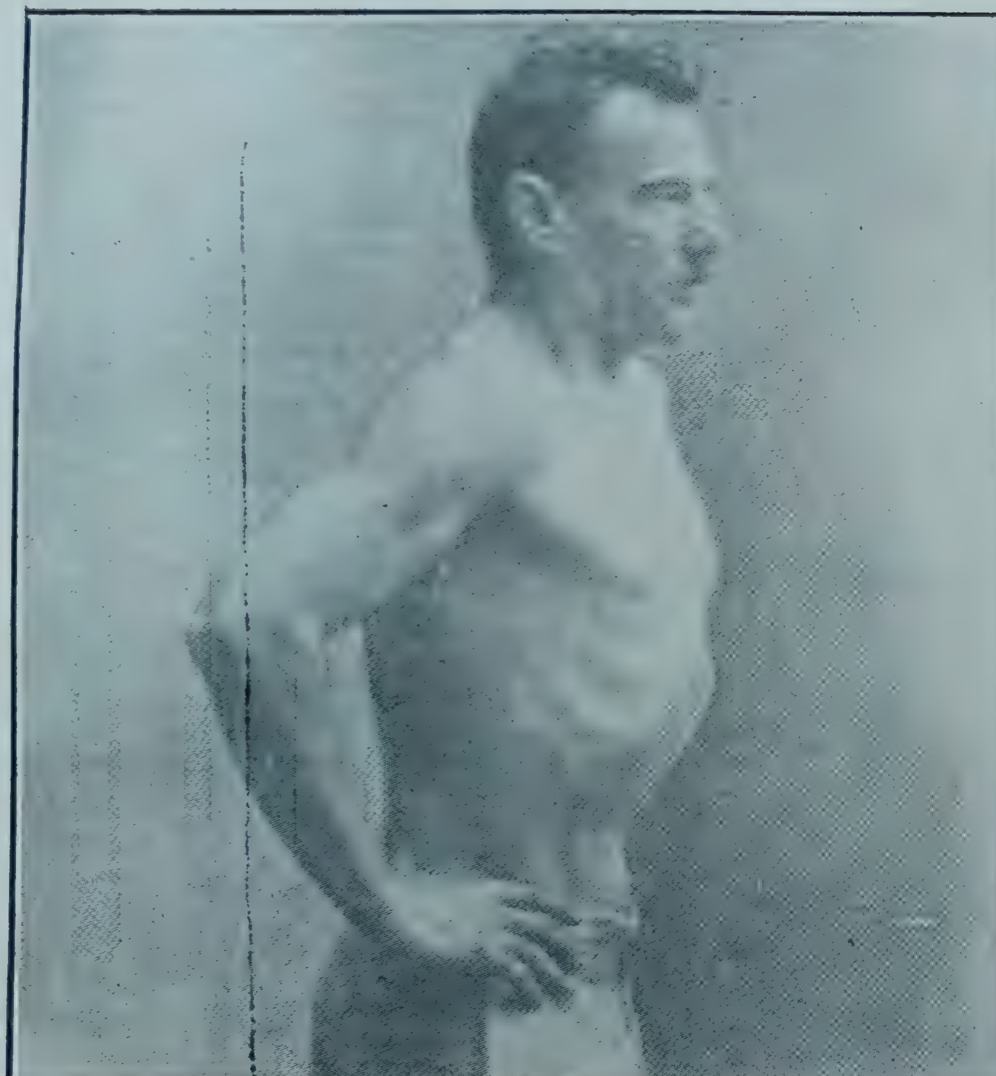
Correct Pose for Abdominal Exhalation.

Fig. V



Correct Pose for Abdominal Inhalation.

Fig. VI



A Wrong Pose for Inhalation.

Fig. VII



A Wrong Pose for Exhalation.

"The muscles which move the ribs are the various intercostal muscles and the serratus major.[1]

"I think there exists a good deal of superstition about the diaphragm, this mysterious organ, which, nevertheless, every man in the street, in his own fancy, knows just as well as his pocket.

"I am convinced that *it is quite impossible to move the diaphragm separately, intentionally or voluntarily*, (Italics ours), although, of course, we move it indirectly by moving the ribs or the abdominal muscles. It would be easier to believe, as is asserted, that certain Hindus are able to arrest the pulsation of their hearts for a short period, because we can locate the heart both by feeling and by hearing it. And in such cases it is easier to get a connection of nerve between the brain and the organ in question. But the diaphragm cannot be perceived through any of our senses, and I, therefore, maintain it is impossible to establish direct nervous contact with it. I know that many people will assert that such movements as are illustrated in Figs. 44 and 45[2] are caused by the diaphragm; but it is impossible to explain how the diaphragm can achieve such results. And there is surely no reason why the diaphragm should perform a thing which is easily done by the abdominal muscles. The diaphragm is a quietly and unconsciously working breathing muscle. But it is easy to perform the movements of Figs. 44 and 45[2], without breathing; or even when breathing in the exactly opposite way, as shown in Figs. 11 and 12[3], where Fig. 11 represents the fullest possible inhalation, and Fig. 12 the exhalation.

"The direct proof of the fact that *nobody can move his diaphragm voluntarily*, (Italics ours), or come into direct nervous contact with it, is that all the sensations which people

1 A muscular sheet covering the upper eight ribs.

2 Reproduced here as Figs. IV and V respectively.

3 Reproduced here as Figs. VI and VII respectively.

imagine that they have in the diaphragm are always actually in the abdominal wall, or perhaps in the stomach or intestines, if you ask a person to point out where he thinks his diaphragm is he will, in nine cases out of ten, put his finger near the navel, or at all events not higher than on a level with the openings of the lower pockets of his waistcoat. But the diaphragm is really situated much higher on the front of the chest, above the point of the breastbone, that is, on a level with the upper pockets of the waistcoat.

" On the other hand, it is quite possible *indirectly* to stop the breathing activity of the diaphragm, namely, when the breath is being held ; which is done by stopping the passage of air through the trachea, the abdominal wall often assisting in the performance by creating a counterpressure when braced. But it is by no means certain that movements of the diaphragm will always result in breathing. It is possible to hold the breath and simultaneously by muscular force to move the ribs, and thereby the diaphragm, to the utmost limits ; in other words, to perform very large, but ' void ' respiratory movements without letting the slightest amount of air pass in or out. "

We have quoted Mr. Muller at length and reproduced his own illustrations because we want him to be faithfully represented to our readers. According to our understanding Mr. Muller reaches the following conclusions.

i The diaphragm is an involuntary or a passive muscle and consequently cannot be voluntarily moved without the help either of the ribs or of the abdominal muscles and viscera.

ii Being itself passive, it cannot move the ribs.

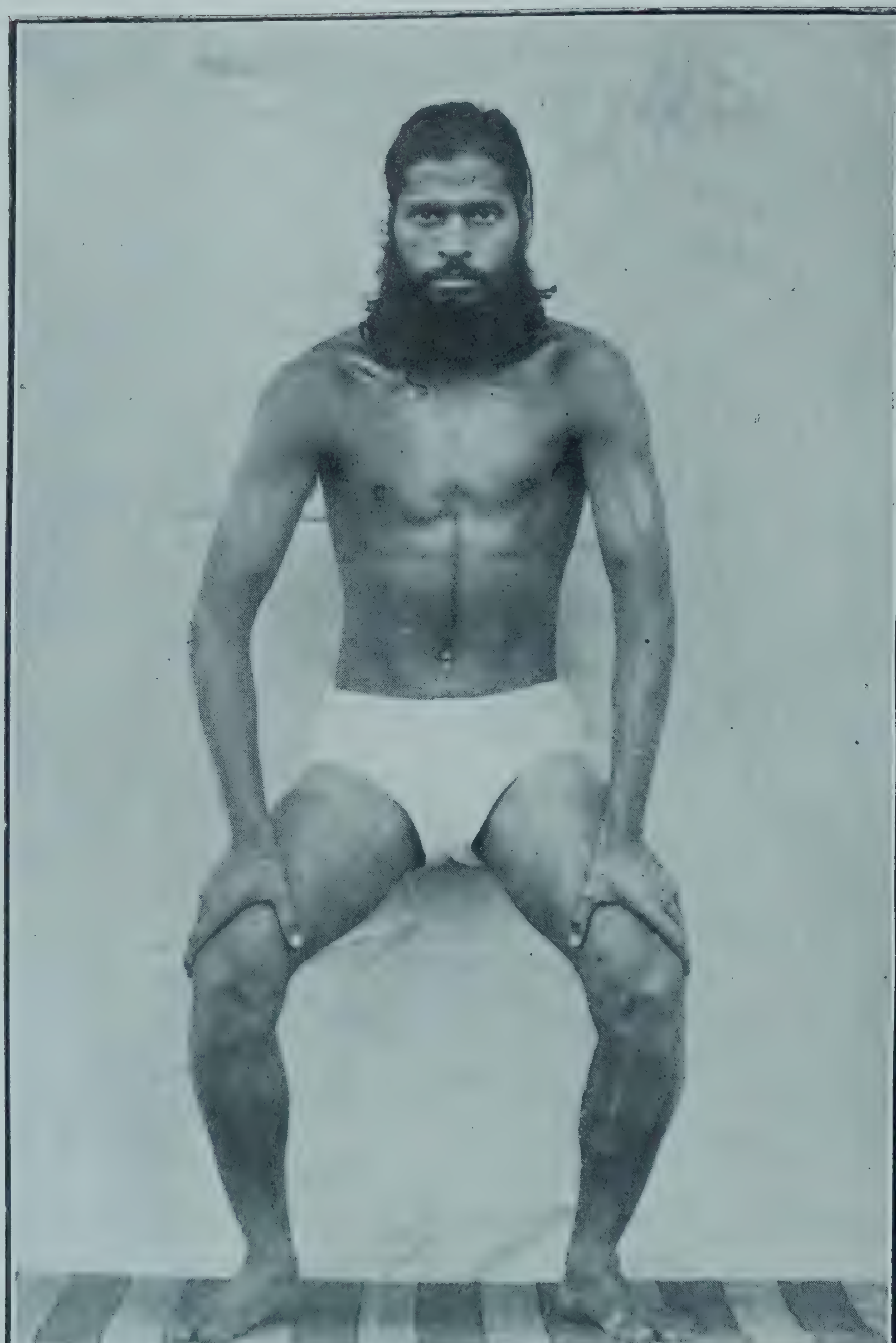
Summing up the whole discussion, we find that the medical scientists hold that mainly the diaphragm moves the ribs, whereas Mr. Muller maintains that the ribs move the diaphragm. Both however, admit that the diaphragm

Fig. VIII



Position of Ribs during Half Expiration.

Fig. IX



Position of Ribs during Full Expiration.

Fig. X



Position of Ribs during Uḍḍiyāna.

sinks when the ribs are raised and that the diaphragm is raised when the ribs sink.

Now if it can be proved that the ribs can be raised either without lowering the diaphragm or without getting the abdominal viscera to act as a fulcrum, the proof will go against the medical scientists. Again if it can be proved that the diaphragm can be raised either without depressing the ribs or without pushing it up by means of the abdominal viscera and muscles, the proof will go against Mr. Muller.

We believe we can prove that the ribs can be raised either without lowering the diaphragm or getting it to act on the fulcrum of the abdominal viscera. So also we can prove that the diaphragm can be raised either without depressing the ribs or without getting it pushed by the abdominal viscera and muscles. Thus we stand the danger of going against both the medical scientists and the physical culturist of the West.

Let us scan the evidence at our disposal and see what it conclusively proves.

First we start with the elevation of ribs.

Fig. VIII represents the position of the ribs when expiration is only half done and Fig. IX shows the position of the ribs after full expiration. Evidently the ribs are more depressed in Fig. IX than in Fig. VIII. Now, if the ribs are to be raised, the diaphragm has to be lowered and pressed against the abdominal viscera, there being no other way of raising the ribs according to the medical scientists, such as Gray and others. In Fig. X the ribs show themselves to be more elevated than in Fig. IX. And this is done not only without lowering the diaphragm and pressing it against the abdominal viscera; but by actually raising up the diaphragm and that too without being pushed up by the abdominal viscera aided by the abdominal muscles. That the ribs are more elevated in Fig. X than in Fig. IX is

evident.[1] But besides the obvious photographic evidence and the evidence given in the foot-note, we have got X-Ray evidence too on this point. Fig. XII represents the normal position of the eleventh ribs and Fig. XIII represents the position of the same ribs during Uḍḍiyāna. Now the angle made by the eleventh ribs with the spine in Fig. XIII, is greater than the angle made by the same ribs in Fig. XII. If a straight line is drawn at the base of the eleventh vertebra and produced to cut the outer borders of the eleventh ribs, it will measure less than 60 mm. in Fig. XII, but more than 75 mm. in Fig. XIII, clearly showing thereby that the eleventh ribs make a greater angle in Fig. XIII, than in Fig. XII; and that they are, therefore, raised higher in the former figure. What is true of these two ribs is also true of the other ribs situated above them.[2]

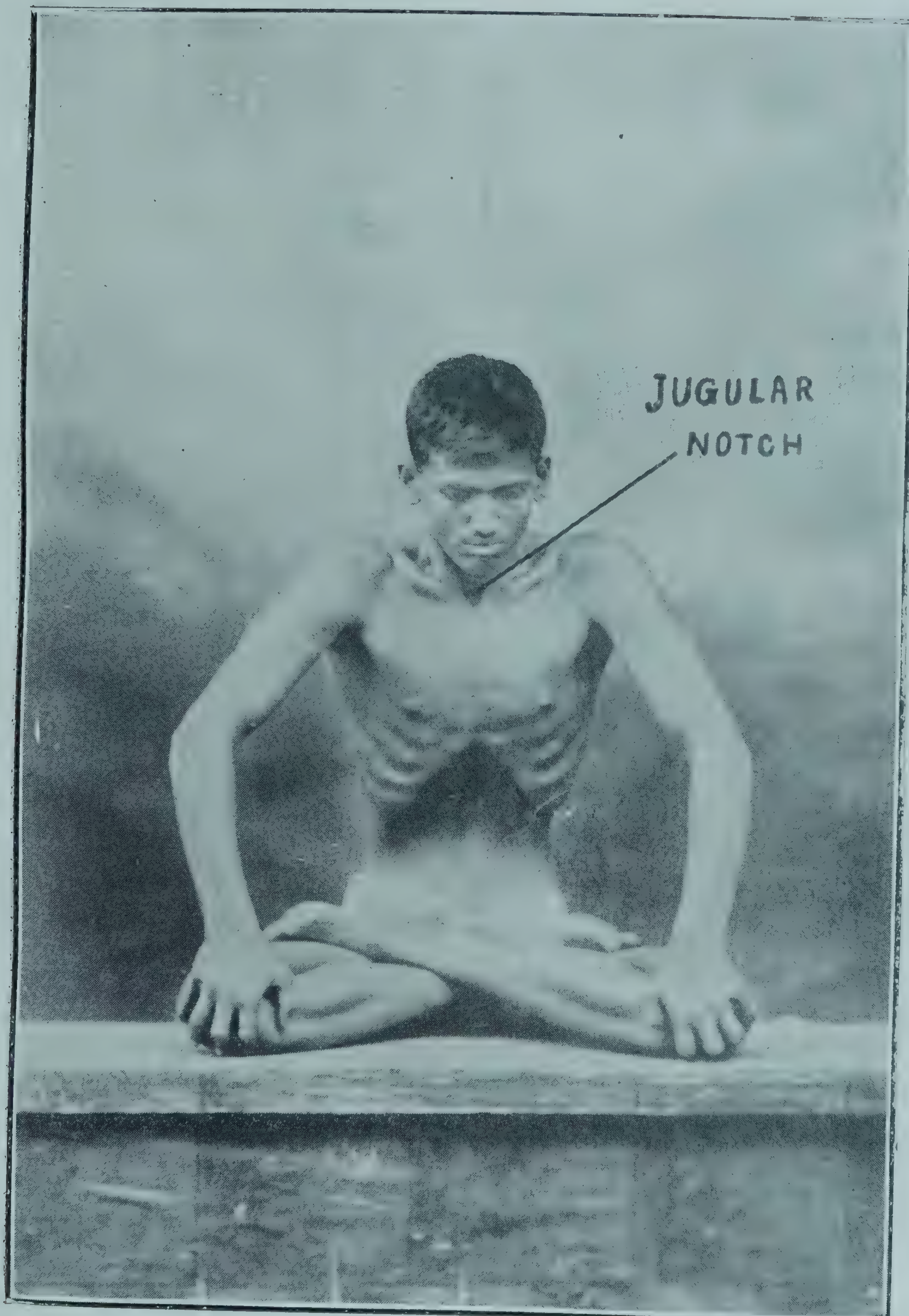
Upto now it has been shown that the ribs are elevated. Now we want to prove that instead of the diaphragm being lowered in raising the ribs, it has been raised and that the diaphragm has not been pushed up by the abdominal viscera aided by the abdominal muscles.

We draw the attention of our readers to the experiments on the intra-gastric pressure given in the beginning of this section. Experiment V shows that the intra-gastric pressure is greater in the position illustrated in Fig. IX than in the position shown in Fig. VIII. This is because the abdominal viscera are pressing against the diaphragm, as the former have been pressed in by the abdominal muscles. The stomach being highly compressed between the diaphragm above and the intestines below, naturally records higher intra-gastric pressure. Now in Experiment I which

1 In the case of the individual photographed in illustrations VIII-X, the difference between the girts, that is, measurements taken round the chest across the seventh ribs, as represented in Figs. IX and X, was found to be more than 5 cm.

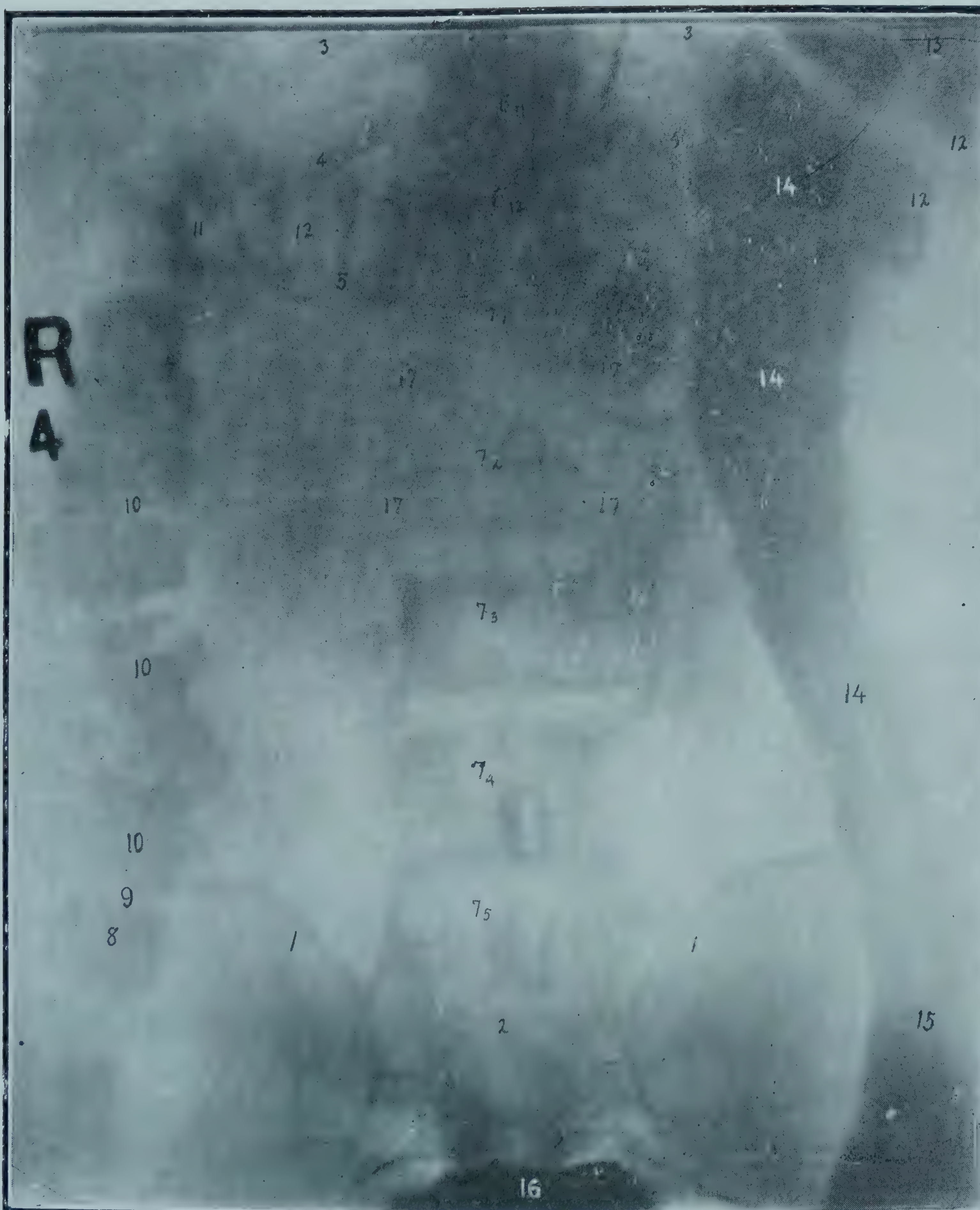
2 The radiographs given here were orginally taken for studying the action of Uḍḍiyāna upon the loaded colon. Hence only the lower ribs have been shown. We propose producing radiographs specially taken for studying the ribs in some future issue of this journal.

Fig. XI



Position of Ribs during Uddiyāna.

Fig. XII **Radiograph I**



Normal Position of the Lowest Ribs.

References to Radiograph 1

1 The Iliac Bones.
2 The Sacrum.
3 The Tenth Ribs.
4 The Eleventh Ribs.
5 The Twelfth Ribs.[1]
6_{11} The Eleventh Dorsal.
6_{12} The Twelfth Dorsal.
7_1 The First Lumbar.
7_2, 7_3, 7_4, 7_5 The Successive Lumbar Vertebræ upto the Fifth.
8 The Cecum.
9 The Ileo-cecal Valve.
10 The Ascending Colon.
11 The Hepatic Flexure.
12 The Transverse Colon.
13 The Splenic Flexure.
14 The Descending Colon.
15 The Iliac Colon.
16 The Rectum.
17 The Transverse Processes.

NOTE—

The bold and black R and 4 have no bearing on the present scheme of references.

1 The twelfth rib of the left side is marked 15 instead of 5.

REFERENCES TO RADIOGRAPH II

1 The Iliac Bones.
2 The Sacrum.
3 The Tenth Ribs.
4 The Eleventh Ribs.
5 The Twelfth Ribs.
6_{11} The Eleventh Dorsal.
6_{12} The Twelfth Dorsal.
7_1 The First Lumbar.
7_2, 7_3, 7_4, 7_5 The Successive Lumbar Vertebræ upto the Fifth.
8 The Cecum.
9 The Ileo-cecal Valve.
10 The Ascending Colon.
11 The Hepatic Flexure.
12 The Transverse Colon.
13 The Splenic Flexure.
14 The Descending Colon.
15 The Iliac Colon.
16 The Rectum.
17 Umbilicus.

NOTE—

The bold and black **0** on the right side of the figure and similar but inverted **3** on the left, have nothing to do with the present scheme of references.

Fig. XIII **Radiograph II**



Position of the Lowest Ribs during Uḍḍiyāna.

measures intra-gastric pressure in the position shown in Fig. X, that is, the position of Uḍḍiyāna, should again show an increase, because the abdominal muscles are now pressed in far more firmly than in the position shown in Fig. IX and must have consequently pushed up the abdominal viscera against the diaphragm more tightly. But the experiment instead of recording an increase, has actually recorded a decrease in the intra-gastric pressure. What does it show? It shows that the abdominal viscera are, indeed, pushed up. But the diaphragm has risen far above them, thus reducing its pressure upon the stomach considerably.

One might, however, say that this is merely an inference and would demand radiographic corroboration of the same. We are glad to state that even X-Ray evidence goes to prove the same thing. Radiograph III and its line drawing that accompanies it, indicate the relative positions of the diaphragm and the loaded stomach in the normal condition that is the condition shown in Fig. VIII. The same stomach and diaphragm have been radiographed in Fig. XVI during Uḍḍiyāna and are shown in its line drawing in Fig. XVII. Here in Figs. XVI and XVII, we clearly find that the stomach has been raised very considerably during Uḍḍiyāna; but the diaphragm has been raised still higher up and that the stomach which tops the abdominal viscera does not at all press against the diaphragm.

To sum up our evidence, we have shown that during Uḍḍiyāna the ribs are raised. The diaphragm is also raised but not by the abdominal viscera which though pushed up are left far below the diaphragm.

Now in the face of this evidence can we say that the ribs are raised only by the diaphragm which lowering itself down uses the compressed abdominal viscera for its fulcrum? We clearly find that we can elevate our ribs not by lowering the diaphragm but in spite of its being raised. So also

REFERENCES TO RADIOGRAPH III

1 The Diaphragm.

2 The Iliac Bones.

3_{11} The Eleventh Dorsal.

3_{12} The Twelfth Dorsal.

3_{12a} The Twelfth Ribs.

4_1 The First Lumbar.

4_2, 4_3, 4_4, 4_5 The Successive Lumbar Vertebræ upto the Fifth.

5 Position of the Thoracic Portion of the Œsophagus.

6 Position where the Œsophagus Pierces the Diaphragm.

7 Position of the Abdominal Portion of the Œsophagus.

8 Position of the Cardiac Orifice.

9 Dhauti Swallowed.

10 The Greater Curvature.

11 The Lesser Curvature.

12 The Pyloric Orifice.

13 A Part of the Duodenum.

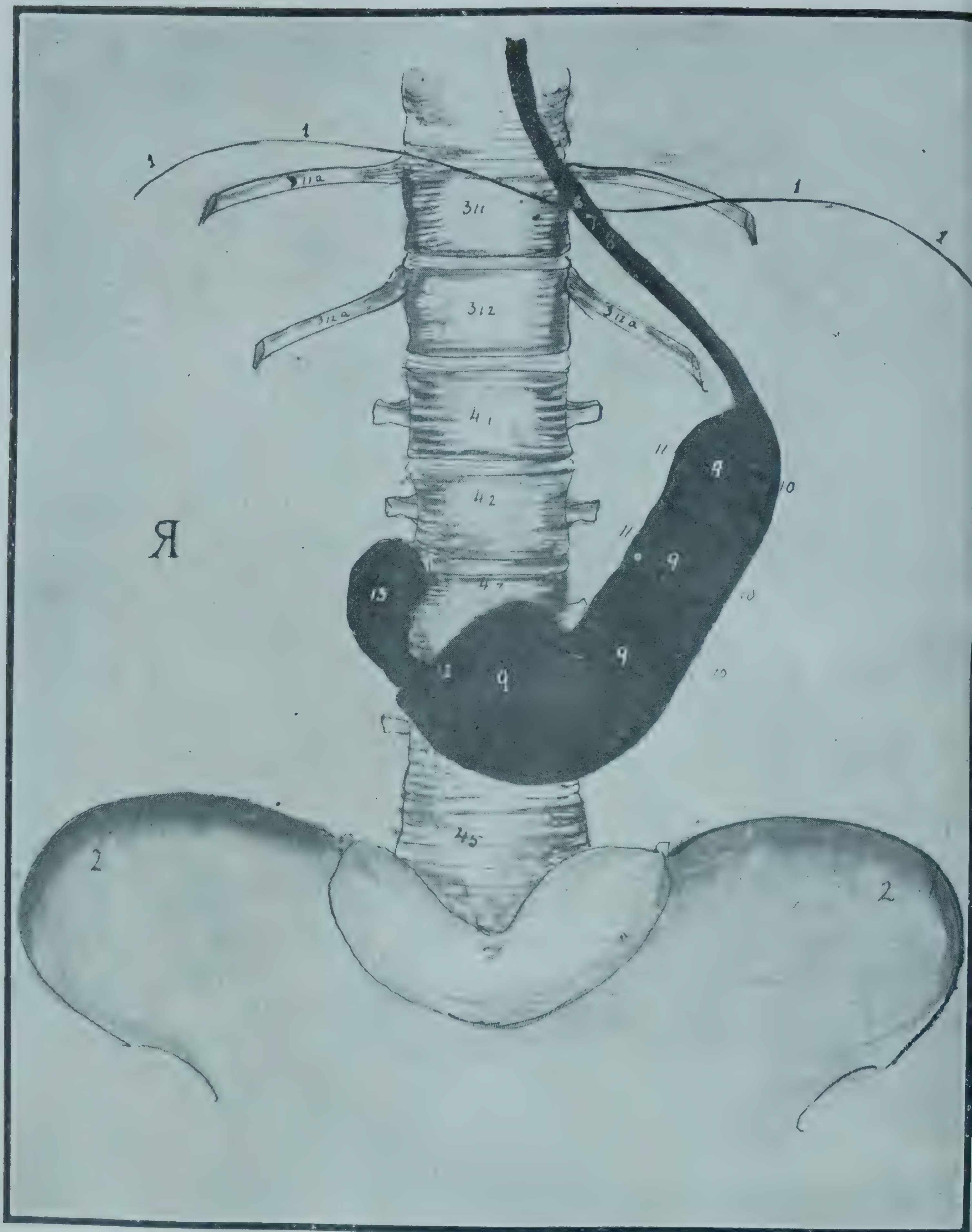
R The Right Side of the Abdomen.

Fig. XIV **Radiograph III**



Position of the Loaded Stomach and the Diaphragm.

Fig. XV



Line Drawing of Radiograph III

REFERENCES TO RADIOGRAPH III

1 The Diaphragm.
2 The Iliac Bones.
3_{11} The Eleventh Dorsal.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4_1 The First Lumbar.
4_2, 4_3, 4_4, 4_5 The Successive Lumbar Vertebræ upto the Fifth.
5 Position of the Thoracic Portion of the Œsophagus.
6 Position where the Œsophagus Pierces the Diaphragm.
7 Position of the Abdominal Portion of the Œsophagus.
8 Position of the Cardiac Orifice.
9 Dhauti Swallowed.
10 The Greater Curvature.
11 The Lesser Curvature.
12 The Pyloric Orifice.
13 A Part of the Duodenum.
R The Right Side of the Abdomen.

REFERENCES TO RADIOGRAPH IV

I The Diaphragm.

2_7 The Seventh Dorsal.

2_{7a} The Seventh Ribs.

2_8 The Eighth Dorsal.

2_{8a} The Eighth Ribs.

2_9 The Ninth Dorsal.

2_{9a} The Ninth Ribs.

2_{10} The Tenth Dorsal.

2_{10a} The Tenth Ribs.

2_{11} The Eleventh Dorsal.

2_{11a} The Eleventh Ribs.

2_{12} The Twelfth Dorsal.

2_{12a} The Twelfth Ribs.

3_1 The First Lumbar.

3_2 The Second Lumbar.

4 Position of the Thoracic Portion of the Œsophagus.

5 Position where the Œsophagus Pierces the Diaphragm.

6 Position of the Abdominal Portion of the Œsophagus.

7 Dhauti Swallowed.

8 The Greater Curvature.

9 The Lesser Curvature.

10 The Pyloric Orifice.

11 Position of the Superior Portion of the Duodenum.

12 Position of the Descending Portion of the Duodenum.

13 Position of the Horizontal Portion of the Duodenum.

14 Position of the Ascending Portion of the Duodenum.

15 A Part of the Jejunum.

R The Right Side of the Abdomen.

Fig. XVI **Radiograph IV**

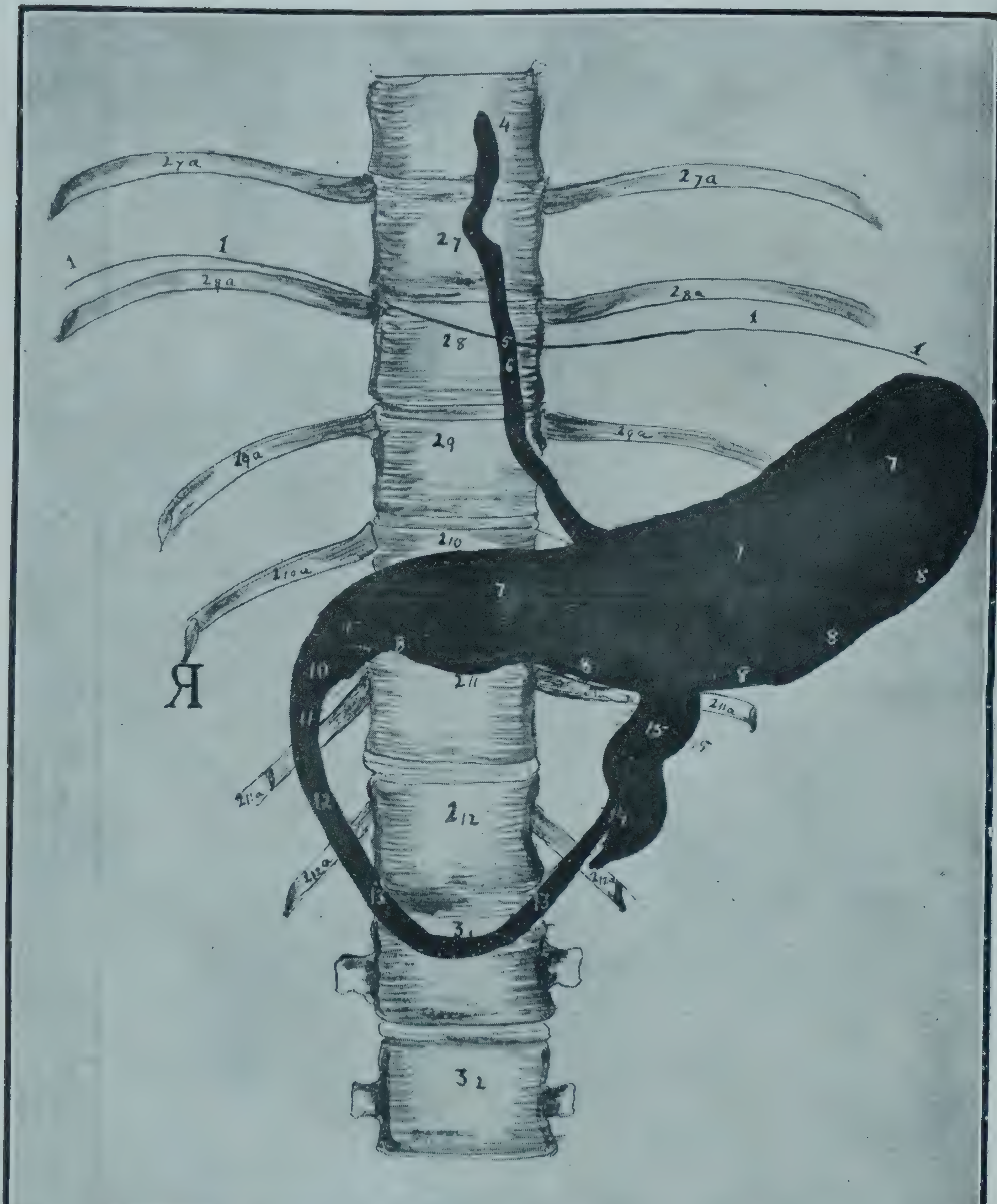


Position of the Loaded Stomach and the Diaphragm

during

Uḍḍiyāna.

Fig. XVII



Line Drawing of Radiograph IV

References to Radiograph IV

1 The Diaphragm.
2_7 The Seventh Dorsal.
2_{7a} The Seventh Ribs.
2_8 The Eighth Dorsal.
2_{8a} The Eighth Ribs.
2_9 The Ninth Dorsal.
2_{9a} The Ninth Ribs.
2_{10} The Tenth Dorsal.
2_{10a} The Tenth Ribs.
2_{11} The Eleventh Dorsal.
2_{11a} The Eleventh Ribs.
2_{12} The Twelfth Dorsal.
2_{12a} The Twelfth Ribs.
3_1 The First Lumbar.
3_2 The Second Lumbar.
4 Position of the Thoracic Portion of the Œsophagus.
5 Position where the Œsophagus Pierces the Diaphragm.
6 Position of the Abdominal Portion of the Œsophagus.
7 Dhauti Swallowed.
8 The Greater Curvature.
9 The Lesser Curvature.
10 The Pyloric Orifice.
11 Position of the Superior Portion of the Duodenum.
12 Position of the Descending Portion of the Duodenum.
13 Position of the Horizontal Portion of the Duodenum.
14 Position of the Ascending Portion of the Duodenum.
15 A Part of the Jejunum.
R The Right Side of the Abdomen

we see that ribs can rise without any help from the abdominal viscera.

So we conclude that during Uḍḍiyāna the diaphragm does not raise the ribs but that there is some other agency which does the work. And further we say that the same agency that raises the ribs during Uḍḍiyāna, or a part of it should be responsible for raising them during ordinary respiration and not the diaphragm. That stands to reason.

But it goes against the accepted theory of the medical world. We have to request, in all sincerity, the medical scientists to scan very carefully the evidence that we have adduced against them and point out the falacy. We shall be very glad to revise our conclusions. But if no falacy could be detected, they should accept the truth of our conclusions and encourage us in our researches.

Now let us examine the theory of Mr. Muller in the light of the same evidence. He says—

"I am convinced that it is quite impossible to move the diaphragm separately, intentionally or voluntarily, although, of course, we move it indirectly by moving the ribs or the abdominal muscles."

What he means is this: If the diaphragm is to be raised, it must be raised by depressing the ribs or by contracting the abdominal muscles and thus giving an upward push to the diaphragm through the abdominal viscera.

But as we have already seen, the diaphragm can be raised not only without depressing the ribs, but in spite of their elevation. So also, not only without an upward push of the abdominal viscera, but in spite of their being left far below the diaphragm.

So the evidence is clearly against the conviction of Mr. Muller. We cannot accept his theory as we could not accept that of the medical scientists.

Our conclusion is that the diaphragm can be raised[1] independently of the lowering of ribs and that the ribs can be raised[1] independently of the lowering of the diaphragm.

Upto now the actions of the diaphragm and of the ribs have been studied within the range of respiration normal or forced. Nobody has tried to see how they act when taken beyond this range. We were enabled to do this because of the Yogic exercise of Uḍḍiyāna and thereby we have reached a conclusion which to us looks to be sound. Within the range of respiration either forced or normal, the ribs do, indeed, rise only with the descent of the diaphragm, and the diaphragm only with the descent of the ribs. But this invariable concommittance should not necessarily indicate any direct causal relation between the two.

(To be continued)

1 How we do it will be discussed in the next issue.

N. B.—The Director of the Kaivalyadhāma entreats every man of means to show his active sympathy for the Ās'rama.

The Semi-Scientific Section

THE DIGESTIVE APPARATUS

(*Concluded*)

THE jejunum ends in the ileum. The latter's diameter is smaller than that of the former, being only 3·5 cm. Its coats are thinner than those of the jejunum. The folds of the mucous membrane are few and small. The ileum is situated chiefly in the umbilical, hypo-gastric, right iliac and pelvic regions. It opens into the large bowel by means of the *ileo-cecal valve.*

The coats of the small intestine are similar to those of the stomach. There are, however, a few features in which they differ. The circular folds of the mucous membrane mainly in the jejunum and also in the ileum have already been noticed. There is another growth which distinguishes the small intestine from the stomach. The mucous membrane of the small intestine presents a velvety appearance because of the growth of minute hairlike projections from its surface. These projections are called *villi,* meaning in Latin, tufts of hair; and are the principal organs of absorption. Each *villus* consists of a very small artery, also a very small vein and a *lacteal* vessal. This lacteal vessal is the real sense of absorption; and is so called because it does not contain blood, but a milk-like fluid (lac=milk) obtained from the food as it passes along the intestinal canal. This milk-like substance is the nourishing element that is afterwards thrown into the circulating stream of the blood and carried to the different parts of the body.

The number of the villi diminishes along the length of the small intestine, till they altogether disappear in the colon.

The small bowel has a secretion of its own. This juice is thrown into the food canal by means of glands that are

buried in the substance of the mucous membrane and are present throughout the intestines large as well as small. They are called *Lieberkuhn's glands*; and are commonly known as *intestinal glands.*

The jejunum and the ileum do not show any difference so far as their structure is concerned, and the division of the small intestine into these parts besides the duodenum is arbitrary. But both of them present particular features which enable them to be distinguished from each other. The jejunum is thicker, redder and more vascular than the ileum. Again the circular folds of the former are larger and more numerous than those of the latter. So also the villi more densely cover the jejunum than the ileum.

The *ileo-cecal valve* is formed by two lips which project into the interior of the cecum from the ileum. They are composed of circular muscle fibres of the small intestine covered over with mucous membrane. These muscle fibres become thick at this point and form a sort of sphincter at the end of the ileum.

The jejunum and ileum are attached to the posterior abdominal wall by an extensive fold of peritoneum, the *mesentery,* which allows of very free motion, so that each coil can accommodate itself to changes in form and position.

The colon has already been described in the first issue of the first volume of this journal.

Now only two *accessory organs* remain to be considered in order to complete our description of the digestive apparatus. They are the two large glands in the abdomen–the *liver* and the *pancreas.* We first take up the liver.

The *liver* is the largest gland in the human body and is situated on the right side of the abdomen just below the diaphragm. The left part of the gland, however, extends a

little beyond the breastbone. A reference to Figs. XL-XLII of the first volume of this journal, will make its position clear. Being a heavy gland weighing about 55 ounces, its position while the man is sitting or standing is a little different from its position while the man is lying down. In sitting or standing, the liver comes slightly below the right ribs, but in lying down it is completely hidden behind them.

The liver is composed of very minute cells. These cells are grouped together in different masses called *lobules*. We shall study the functions of the liver in a separate chapter on *digestion* in the next issue. Here suffice it to say that the activity of the liver is carried on in these tiny cells with the help of the blood that is brought to them in the following manner. We shall presently see that a vein called the *portal vein* comes to the liver and brings with it blood nourishing material obtained from the stomach and the intestines. This portal vein, on reaching the liver, is divided and subdivided into very minute vessels forming a network of capillaries that surround the lobules of the hepatic cells. Finest blood streams from these capillaries spread to the cells and enable them to carry on their activity.

The venous blood is brought to the liver through a single vessel called the portal vein. But this blood is sent out by the liver through two channels. From the venous blood brought to it, the liver separates particular material which is manufactured into the *bile* and sent out through a separate channel called the *hepatic duct*. Remaining quantity of the venous blood is also worked upon and with some new products is sent out through a separate channel called the *hepatic vein*.

We have already noticed the *bile-duct*, (vide p. 268, Vol. II) and now we want to see how the bile that is manufactured in the liver is taken to it. The bile from the cells is first thrown into very minute ducts which afterwards join together to form the hepatic duct. Now this hepatic duct, joins the bile-duct, (see Fig. XVIII), but it does not pour

the bile into this duct, if it is not immediately needed for digestion. The bile is then sent through the cystic duct to the gall-bladder where it is stored up till required for digestion. Both the hepatic duct and the cystic duct join the bile-duct which itself opens into the duodenum as previously noted.

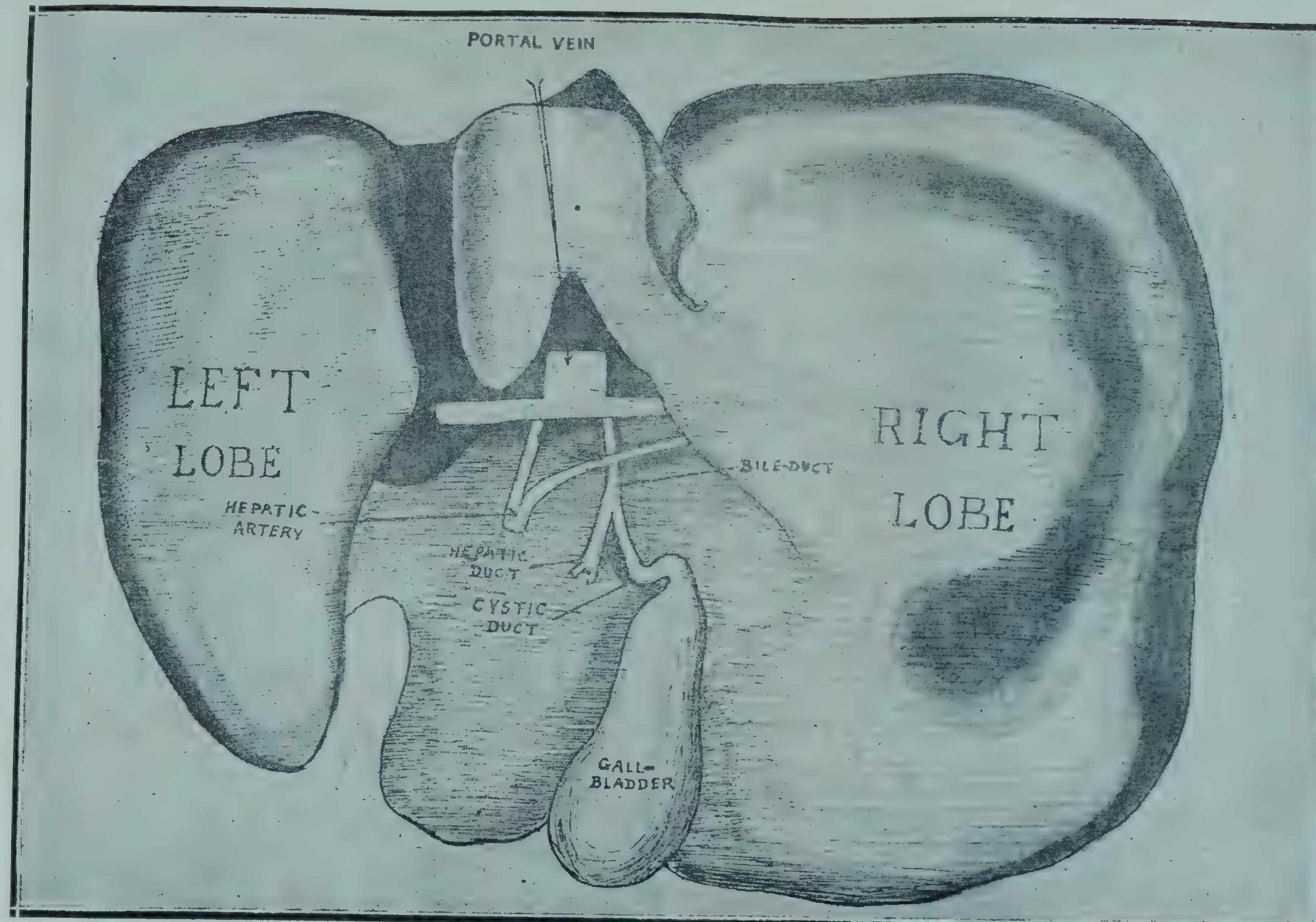
The blood brought to the liver by the portal vein is impure. This organ gets its pure blood supply from the *hepatic artery.* (See Fig. XVIII).

The *pancreas* is another important gland situated in the abdomen and directly connected with digestion. It weighs only two to three ounces and is irregularly prismoid in shape. It is placed across the posterior wall of the abdomen and a part of it is lodged in the curve of the duodenum, the remaining portion being hidden behind the stomach. This gland has a secretion which through minute channels is poured into a duct which crosses the whole length of the gland, and issuing out of it joins the duodenum along with the bile-duct.

The *blood-vessels* that supply the different parts of the digestive apparatus, are all derived from one big artery that runs down the abdomen in front of the spinal column. We mean the abdominal aorta. (See Fig. LXXXIX, Vol. I). So also all the blood-vessels that drain these organs unite and ultimately form one big vein called the portal vein. The arterial blood while circulating through the digestive organs is enriched with nourishing material which it carries to the liver, that gland disposing it off either through the hepatic vein or through the hepatic duct.

The *nerve supply* of the digestive apparatus is derived both from the central nervous system as well as the sympathetic. We do not give any details here about this supply, as the same will be better discussed with the different problems connected with digestion.

Fig. XVIII



The Liver.

THE RATIONALE OF YOGIC POSES

(*Continued*)

THESE exercises belong to the respiratory system and fall under the general name of Prānayāma. As we have not discussed these breathing exercises in our journal upto now, we cannot enter here into any details. We shall select only one breathing exercise called Bhastrikā and discuss a few points of importance bearing upon it.

This exercise consists[1] of incessant blowing out for a short period followed by a deep inspiration or at times complete expiration. Each expulsion of breath which is required to be sudden, is followed by a slow and automatic inspiration. The scope of this article precludes the idea of giving any more information on this point here. The features mentioned in the foregoing lines are sufficient to give a general view of what the exercise is like.

Now it is well-known to students of physiology, that respiratory movements have a great influence upon the volume of the brain.[2] If there are no interfering factors, the brain increases in volume with each expiration and decreases with each inspiration. That means the brain is constantly heaving. This repeated rise and fall in the volume of the brain is very closely connected with the speed of blood circulation in that organ, so that if the speed of this heaving is accelerated, the blood circulation in the brain also will be accelerated, and the supply of fresh blood to the brain will become quicker. This is what is exactly done in Bhastrikā. As many as 120 expulsions per minute would not be considered too fast a speed for this exercise.

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1 Readers will do well not to think of practising this exercise without proper guidance.

2 This and other points connected with this topic will be discussed at length in our 'Note on Respiration' in the subsequent issues.

The circulation becomes faster and the brain gets fresh blood on a larger scale.

During the exercise of Bhastrikā, all the muscles of the back that hold the spinal column in place, contract and relax alternately. This leads to the alternate compression of the spinal vertebræ. These movements of the muscles and bones induce a richer blood supply to the spinal regions. Thus both the brain and the spinal regions get larger quantities of fresh blood and are toned up by this exercise of Bhastrikā. Naturally the roots of the nerves situated in these parts are also toned up.

After considering the roots, we come to the trunks of the nerves and their branches that spread over the whole human body. Even these are taken care of in Bhastrikā. This is done in two ways.

i Promotion of blood circulation roundabout the nerves.

ii Nerve Massage.

We have got laboratory evidence to prove that Bhastrikā not only quickens the blood flow all over the body, but it also makes the same richer in quality.[1] This enriched and swifter blood circulation adds fresh vitality to the nerves situated in every part of the physical frame.

Again by this exercise of Bhastrikā the remotest extremities of the branching nerves are massaged. Although we have not got to-day any laboratory evidence to prove our statement, it is a common experience of the students of Yogic culture, that a prolonged practice of Bhastrikā produces vibrations in every tissue of the human body. Yogic texts refer to these vibrations.

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1 In our laboratory we are at present conducting experiments on the blood-count of Yogic students. These experiments with their conclusions will be published in the pages of this journal in due course of time. They are likely to prove Bhastrikā to be the finest exercise that human genius has ever invented for the circulatory and nervous systems.

Now the vibrating tissues of the muscles massage the nerves that spread through them and keep them to better health.

Even to those who would not credit the statement made in the last paragraph for want of laboratory evidence, another type of nerve massage can be brought home. But a discussion of this point requires knowledge of anatomical and physiological details which we have not given in this journal upto now. Hence we have to reserve this topic for some future occasion.

What we have stated above, however, in connection with the nerves, is sufficient to prove that the Yogic system of physical culture has excellent exercises for developing the nervous system as a whole. It should be noted here that the Āsanas help the roots of the nerves and do not much concern themselves with the trunks and the branches directly. They do directly help the brain, the spinal cord and the sympathetic nervous system, however.

Next we go to the endocrine glands. In our article on the Pan-Physical Pose, we have conclusively proved that Āsana to be an excellent exercise for the thyroid. We have again shown in the same article that the pose also looks to be capable of improving the parathyroids. In the last part of that article we have seen that Sarvāṅgāsana helps to improve the testes and there is reason to believe that it also promotes the health of the ovaries. The pineal gland, the pituitary body and the adrenals have not yet been studied from the Yogic point of view.

The thyroid, the testes and the ovaries are, perhaps, the most important endocrine structures, so far as the general health of persons is concerned and through Sarvāṅgāsana Yogic physical culture is competent to keep them in good health.

After endocrine glands we go to the excretory organs. As stated in the previous issue, the intestines, the liver and the kidneys are the principal organs of excretion. No in

our article on *cecal constipation,* we have shown very satisfactorily that the two exercises of Uḍḍiyāna and Nauli are peculiarly capable not only of keeping the large bowel healthy but also of restoring a degenerated colon to health. What applies to the colon also applies to the liver and the kidneys. In our clinical work in the Ās'rama, we have found Uḍḍiyāna and Nauli giving very good results in the treatment of a sluggish or enlarged liver and dull kidneys.

S'īrshāsana, Sarvāṅgāsana, Dhanurāsana and Bhujaṅgāsana are all capable of promoting the health of the excretory organs. In the cases of patients unable to pick up Uḍḍiyāna and Nauli, we have found the above Āsanas bringing great relief to the sufferer.

But the efficacy of breathing exercises would prove equal to that of Uḍḍiyāna and Nauli, if not superior, in this regard. As we have not yet detailed these exercises here, we satisfy ourselves only by making a mention of these in this connection.

So for the health of the excretory organs, the Yogic system of physical culture has excellent exercises. The Āsanas, though they do not constitute the best of these, are still capable of doing much to keep the excretory organs healthy. It may be noted here that no other system of physical culture can show exercises that can compare with Uḍḍiyāna, Nauli and Prāṇāyāma.

We have next to take into consideration the circulatory system. In this connection we have to look to the health of the heart, arteries and veins. Out of these we have made a detailed study of the venous blood circulation in our article on the Pan-Physical Pose. On p. 292 and the following of the first volume, we have seen that the Yogic method of helping the veins to health and enabling them to preserve it, is entirely different from the methods of the non-Yogic systems. We have also seen there that the Yogic

method requires the least amount of energy to be expended in this regard.

Nature has made ample provision for the preservation of the health of these supremely important parts of the circulatory system. A sort of self-massage has been arranged; and both the heart and the arteries are as constantly being massaged by themselves as they are working. Yogic savants have taken full advantage of this natural provision in the circulatory system and have very ingenuously invented exercises to help Nature according to her own plan of action.[1]

As we have not given any details of this self-massage of the arteries and the heart, and also of the exercises invented by the Yogic seers in its aid, it would not be possible for us to institute any comparision between the Yogic exercises and the non-Yogic exercises available for the same purpose. We may, however, make the following statement and request our readers to wait for the arguements that prove it, till we take up the question for a detailed discussion. So far as the massage of the arteries is concerned, the non-Yogic exercises do not suffer from any great disadvantage. But so far as the heart itself is concerned, the non-Yogic exercises suffer from some serious drawbacks.

Thus, we think, the Yogic system of physical culture takes care of the circulatory system far more efficiently than the non-Yogic systems. The Āsanas, however, help only the veins. They very little concern themselves with the arteries and the heart.

Next we come to the muscular system. Whatever the physiological importance of this system as compared with

1 It is not only in the case of the circulatory system that the Yogic savants have exercises for promoting self-massage. It is no exaggeration to say that they have planned exercises for giving automatic massage to nearly every tissue in the body and whereever necessary have made provision for getting the oilly moisture from the body itself to make the massage comfortable and smooth. Again all this is done at the minimum expenditure of physical energy. Most of these exercises have been included in the list given on p. 219 of the second volume of this journal. This extremely interesting side of Yogic physical culture we promise to discuss in some future issue of this journal.

the other systems working in the human body, muscles play a very important part in the development of the society. They are the organs through which the mental faculties of man express themselves in the practical world. The intellect, the emotion, the will, all have to depend upon muscles for their practical work. It is the muscles that have built all the roads, all the cities, and all the machines in the world, written all the books, spoken all the words, and, in fact, done everything that man has accomplished with matter. Such being the practical importance of muscles, it is worth while to see what the ancient Yogic savants have done for their culture.

It has been repeatedly stated in the pages of this journal that the ancient Yogins concerned themselves with muscles only incidentally. But this is not to be taken to mean that they have neglected muscle culture. On the contrary it will be seen that they have clearly grasped the fundamental principles underlying this branch of physical culture and that their efforts would be helpful even to a man of this decade, provided he cares to understand and take advantage of them. In the following few paragraphs, we shall examine Yogic muscle culture in the light of the work done by the modern physical culturist of the West.

The love of the West for muscular development is admitted on all hands. Out of a host of physical culturists, each one claiming to have *discovered* the best system in the world, Mr. Maxick looks to have approached the subject of muscle building with some scientific insight. His statements also appear to have much balance in them. He too, however, claims to have discovered the secret of muscle culture. Let us first see what he has to say about his achievement, so that we well be in a position to ascertain whether or not he was anticipated centuries ago by the ancient Yogic savants of India, in understanding the secrets which he thinks he was the first man in the world to discover.

We beg to quote here the very words of Mr. Maxick from his book, *Muscle Control*. He says—

"I feel it necessary that I try to explain myself as clearly as possible on this important point even at the risk of repeating myself.

"The newly-born child possesses a certain amount of mechanical control over its muscles, inasmuch as it can move and stretch its limbs in any possible direction; and this is the beginning of the control possessed by the average human being.

"According to the art of profession adopted, different groups of muscles are brought more or less under control by the method of constant repetition.

"In most cases the muscles are brought to this state of obedience by external influence, and not by the individual himself.

"Many years may therefore be spent in controlling a few groups of muscles that might have been brought under absolute control in a few months if the muscles had been controlled by the individual in a scientific manner.

"The reason why muscles take so long to bring under control by outside influence I have already explained when I pointed out how other muscles are constantly involved, which hinder the movement and control of the muscles particularly required. As time goes on, the unrequired muscles fall gradually into passivity of themselves; but as already mentioned, years may pass before this happens, and possibly the individual may have given up his work in sheer discouragement, having lost hope of ever attaining exceptional or even ordinary skill in his art, profession or craft.

"A simple example may be given. Take a student of the piano. However great his musical talent may be, he will never be able to express himself on the key-board perfectly until his fingers are under absolute control of the

mind. How very few achieve greatness as pianoforts *virtuosi* is well known to those interested; for although thousands of students spend their whole time studying at the conservatories and under eminent masters, the really great may be counted on the fingers of two hands.

"This failure in those who evidently possess artistic ability is due always to a lack of proper muscular control. The fingers will not obey the mind of the performer. He knows perfectly well where they ought to go, and where he desires them to go, but they insist upon touching the wrong notes, and in producing the wrong quality of tone.

"The trouble is usually, if not always, caused through the actual tendons and muscles of the hand hindering the action of the flexor and extensors of the forearm.

"This brings me once more to the subject of relaxation which is one of the necessary conditions for successful muscle-control.

"Relaxation is just as important as contraction, for unless a muscle be supple enough to lie soft when relaxed, real control is out of the question.

"This applies not only to the particular muscle, but to those surrounding, or those muscles which come into direct contact with, and are governed to a certain extent by, the said muscle.

"The control of the surrounding muscles will in turn be hindered by the proximity of a muscle or group of muscles that will not absolutely relax."

In this lengthy quotation, apart from his general theory that muscle control is muscle culture, Mr. Maxick seems to have enunciated two principles, namely—

i Wilful relaxation of muscles is as essential for muscle control as their contraction.

ii For the real control over a particular muscle, one must know how to contract that muscle while keeping other muscles roundabout it perfectly relaxed.

(*To be continued*)

The Popular Section

Fig. XIX



Jihvā-Bandha or The Tongue-Lock.

JIHVĀ-BANDHA

or

THE TONGUE-LOCK

This Bandha is secured by tightly pressing the upper surface of the tongue against the hard and soft palates forming the roof of the mouth, the borders of the tongue being accommodated by the side of the encircling teeth of the upper jaw. The middle line of the tongue is composed of tough fibrous tissues and can exert an upward pressure upon the palates more effectively than the side muscles. The tightened tongue covers the whole of the hard palate and as much of the soft palate as lies between the hard palate and the line joining the farthest teeth on the two sides. Those parts of the tongue that lie beyond this line and descend into the throat, experience an upward pull brought on by the stiffened and uplifted tongue. In Saṅskṛita Jihvā means the tongue and Bandha means a lock. Fig. XIX illustrates the position of the tongue in this practice.

The Tongue-Lock can be practised independently or as a part of Viparīta Karaṇī which will be explained presently. In both these cases the mouth is kept shut up. There is one occasion, however, when the lock is required to be done with an open mouth. This is when Jihvā-Bandha is being practised as a preliminary to Khecharī. A prominent feature of this Mudrā consists of hiding and raising the tongue behind the soft palate. These movements of the tongue are checked by the frenum, which ties that organ to the ground below. (See Fig. XIX). Hence this tie is required to be cut. The traditional position to be given to the tongue when the frenum is to be cut for Khecharī, is obtained by doing Jihvā-Bandha.

NOTE—

This Bandha has been given here with a view to enable our readers to understand Viparīta Karanī properly. On some other occasion the lock will be taken up for an exhaustive study. When practised with an open mouth, it is an important exercise for the organs of senses and especially for the drum of the ear, if it is made to alternate with Siṅhāsana or the Lion Pose, which will be explained in some future issue. Suffice it to say here that the Lion Pose requires the tongue to be fully drawn out, with the jaws widely opened.

When Jihvā-Bandha and the Lion Pose are being practised together in a rapid succession, the posture need not be changed every now and then, but should be maintained throughout the exercise. Only alternately the tongue may be detached from the upper jaw and thrown out. Locking up the tongue and letting it out, each should be done, about twelve times in a minute.

For the purposes of physical culture the Tongue-Lock and the lingual position of the Lion Pose, may be practised independent of any Āsana.

In this short article we have purposely avoided all technical terms in anatomy and physiology. These terms as connected with this practice, will be first explained and then used, when we give an exhaustive treatment to this subject.

VIPARĪTA KARANĪ

or

THE INVERTED ACTION

THE NAME :—

The action is called Viparīta Karanī, because in this practice, the whole body is inverted or stands upside-down. In Sanskrita Viparīta means inverted and Karanī means an action. The Yogic texts give an interpretation of this practice which we have not yet succeeded in exactly interpreting in terms of modern anatomy and physiology. When we do that, we shall be able to give a better explanation of the name by which this practice goes.

THE TECHNIQUE :—

The student first lies supine on his seat with all his muscles completely relaxed, and his mind thoroughly concentrated. Then he slowly raises his legs through the hip-joint till they make a right angle with the ground, all the while maintaining stiff knees. Upto now he does not bring into action his arms and elbows which play only a passive part. But now in his subsequent movements, he has to use his arms and elbows somewhat actively. Because he now raises his hips and curves up the trunk, keeping his legs in the same erect position, that they have already asumed. The weight of the body thus raised, has to be supported by stiffening the arms that are still stretching along the ground. Here the trunk does not make a right angle with the ground as in Sarvangasana, but simply takes an upward curve. Then the

forearms are bent through the elbows and the hands are made to support the curving frame at the hip-bones, as shown in Fig. XXI. The posterior parts of the head, of the neck, of the shoulder-blades, and of the arms upto the elbows are made to lie along the ground, as seen in Fig. XX, which gives the side view of Viparīta Karanī. The chest does not press against the chin as in the Pan-Physical Pose, but keeps itself away from the chin. The eyes are either closed to concentrate the mind upon a particular part in the body or are kept fixed upon the toes. Then the student forms the Tongue-Lock as explained in the last article and thus completes the Inverted Action. Fig. XX illustrates the action as seen from the right side of the student, whereas Fig. XXI represents the same as seen from the back.

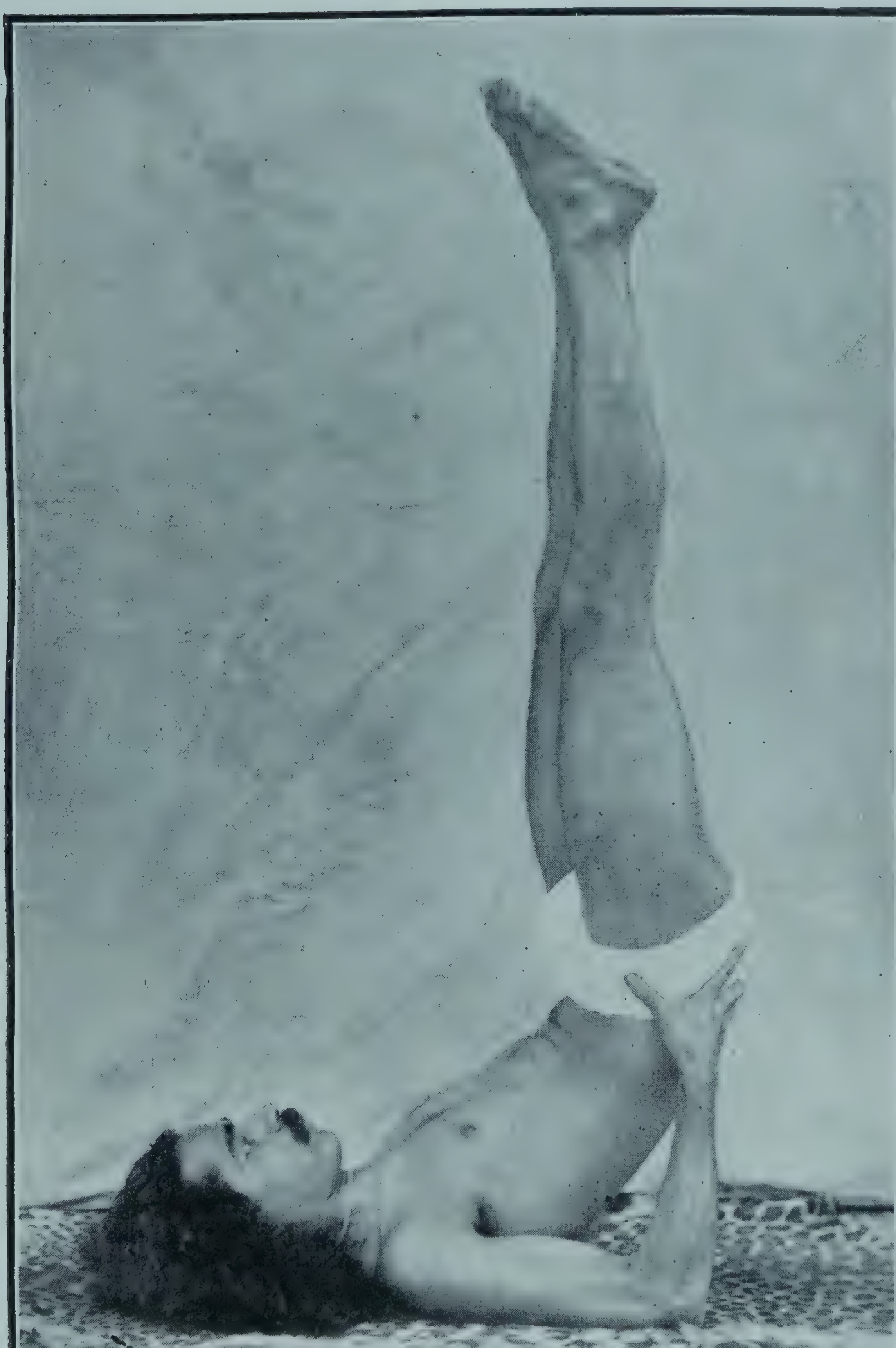
According to the Yogic texts, the practice begins with 24 seconds on the first day, adding a few seconds every day to the period. The maximum stated is three hours. For an exclusive practice of Viparīta Karanī in the case of an ordinary man, we would recommend twenty-four minutes as the maximum. But if this Inverted Action is to be gone through along with other exercises, we would reduce the maximum to six minutes only.

POINTS OF STUDY :—

(a) *Blood-vessels :—*

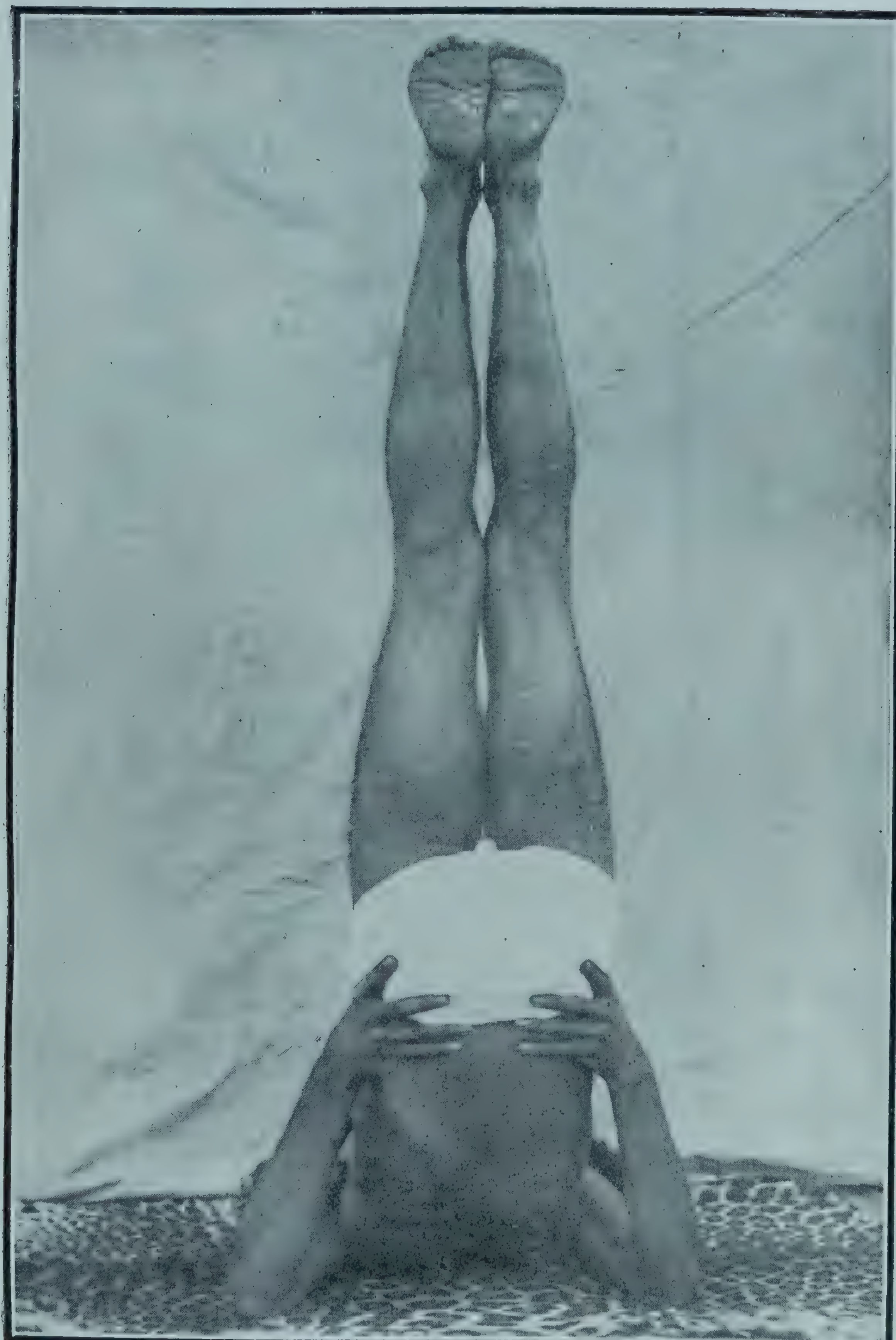
The arch of the aorta, the common carotids with external and internal carotids, the innominates, the subclavians, the inferior and superior thyroids are all inverted and send a richer blood supply to the organs situated in the cervical region

Fig. XX



Viprīta Karanī or The Inverted Action.
(Side View)

Fig. XXI



Viparīta Karanī or The Inverted Action.
(Back View)

and above it. Although the thyroid does not get a special share of the fresh blood, yet it gets a fair share in common with other organs of this region. The brain gets a larger supply in this than in Sarvāngāsana.[1]

(b) *Vertebræ :—*

The cervical and the dorsal vertebræ receive a steady pull in this practice.

(c) *Nerves :—*

The brain, the medulla oblongata, the roots of the cranial nerves, the upper part of the spinal cord, and the cervical ganglia of the sympathetic are all specially toned up.

NOTE—

In Haṭha-Yoga the Inverted Action is looked upon as the most important practice capable of developing supreme vitality. It is said to be so wonderfully effective that it would rejuvinate an old body in six months. We do not propose any examination of these claims here. One thing is certain. The practice combines, though on a humbler scale, all the advantages of S'īrshāsana and Sarvāngāsana, and as such must have great influence upon the vital forces in the body. All the cautions, however, that are given to the students of S'īrshāsana and Sarvāngāsana, are also to be given to the students of this practice.

The points of difference between the technique of Viparīta Karanī and that of Sarvāngāsana should be carefully noted and observed in practice. A confusion between the two is sure to disturb the results expected of each of these exercises.

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1 For a chart of these blood-vessels vide Fig. XXIX of the first volume.

DIGESTIVE DISTURBANCE IN ADOLESCENCE

As we are going to discuss the question of dyspepsia in this volume we want to point out its relation to adolescence in which it threatens to be the most common disorder. In this connection we are giving some lengthy extracts from Dr. Hall's *Psychology of Adolescence* which beautifully summarizes the relation between adolescence and dyspepsia. After going through these extracts our readers will be convinced that for about ten years after the age of puberty, youths must not only be careful about their diet, but must also undergo exercises that keep off dyspepsia. Yogic exercises will be proved to be very important in this connection. We would, therefore, strongly recommend adolescent persons to take to these exercises, and avoid the most frequent disturbance of their age. To quote Dr. Hall—

"We now pass to consider the special morbidities of adolescence. Very prominent among the physiological disturbances of the age are those of indigestion and disorders of the alimentary canal, and especially of the stomach. The rapid bone growth requires more lime, the blood needs iron, the increased metabolism more oxygen and more fats for it, perhaps the brain more phosphorus, the muscles require more protein and muscle work more inogen and myosin to break down, and normally the food supply is increased with height and weight, and the chemical bookkeeping of income and expenditure readjusted. The body in general may be conceived as a machine for the conservation of energy which it receives originally from the sun, from which its every element came,[1] and of which we are all children, and indirectly from clorophyl,[2] which is our kinetic basis like a bent bow. In a high sense every organ

1 This is an extreme view and should be taken with due reservation.

2 Colouring matter of the green parts of plants.

is a digestive organ, even the brain itself, and thought perhaps has a digestive function. Man is what he eats and what he does with it, through all the intricate formulæ of physiological chemistry.

"There is a sense in which the basal will to live is simply the will to eat and in which this latter is the basis of psychology. Nearly three-fourths of the total energy of the body, expressed kinetically, probably goes to digestion and half the struggle of life is for food. The very cells of our embryo, as they grow large so that their surface diminishes relatively to their content, must divide or die of starvation. Most of the movements of every form of life that has ceased to be sessile are to get food; organs of locomotion are to get to eat or to escape being eaten by enemies. In the primitive struggle for survival, when two hostile creatures meet, one is destined to be the food of the other. The first fear is that of being devoured; the first form of property is accumulated food. Almost every living being is the food for some other, even the organs of our body struggle in rivalry for the food which the blood brings, and every form of disease and death itself is caused by cutting off the food supply from some group of cells. Sleep is to feed and build up again the nuclei of cells, which under the microscope are seen to have been worn away by activity, and to remove the chip pile of dead matter. What we call hunger is the massed and unconscious desire of every cell for the food it needs, and death in every form may be in a sense said to be due to progressive local or general starvation.

"These general considerations, which I conceive to be the basis of the new genetic psychology of the future, may serve to give us due appreciation of the special importance for adolescence of the general law that there is a trophic or nutritive background to everything and to suggest that the profound metamorphoses of puberty involve adjustments far more radical than are usually imagined. Almost all

returns to our food questionnaires, show that the appetite, which, if natural, is like a compass pointing to the true pole of our somatic needs, is often gravely disturbed at this period. Nearly all report changed appetite. Foods, very prominent in the habitual dietaries before, are now neglected and new favourites arise. This change is especially marked with regard to sweats, acids, fruits, meats, and stimulants. There is a new tendency to experiment, not only with new dishes, but often with things strange and even offensive. Boys dare each other to taste, eat, or swallow offensive and sometimes harmful things, or force their mates to do so, sometimes with disastrous results. Boys sometimes affect or boast of their achievements in eating, and girls affect daintiness, become exceedingly discriminating in sweetmeats, bonbons, summer drinks etc. Boys have eating and drinking matches and duels, and intemperance very generally takes its rise here. It is irregular, fasting and feasting perhaps alternate, strange whims arise with sometimes extreme dislike of some one and passionate fondness for other kinds of foods. Taste seems to acquire a more inward and independent quality of its own, and junkets dainty-mouthed and perhaps stealthily, on titbits. Girls in particular become squeamish, fastidious, and lickerish, and perhaps develop a sweet tooth of disproportionate dimensions. It is never so hard to establish a well-balanced dietary, and yet this is the nascent period for it. Perverse tastes may grievously interfere with health, and the rectification of appetite may be hard just in proportion as plasticity of this age passes into settled bad eating habits of later life.

"I am convinced that one of the causes of diseased cravings, which may lead to wrong food habits and to intemperance, is due to the fact that the normal changes of appetite for both quality and quantity of food are perversions of normal appetite so often unnoticed and unmet. Now judicious oversight, perhaps eked out by a little wholesome authority, does more to push the psycho-physic

organism on to pass safely over the immature stages and dangers of arrest and to come to full maturity with a real maximum of utilized nutrition, than almost any other influence. Very many of the failures of middle and later life are due to avoidable errors of diet, and the arrest thus caused. Not malaria, but perverted appetites, sometimes aided by adultrations and bad cooking, are one of the causes of human degeneration, because man, who ought to be polyphagous[1] and can only with increased difficulty adopt a new food after the period of sex development, is really not fed according to his physiological needs. This is not only the cause of many breakdowns among pupils and students, anemias and most of the meladies of malnutrition so common at adolescence, but of that disquiet, weakness, and lust for stimulants, which in part directly and in part indirectly causes the appetite for drink, by producing either the extreme fatigue under only normal strain, that often has recourse to it, or else this craving is due to lack of proper exercise which so strongly prompts to the quest of artificial excitement."

1 Feeding on various kinds of food.

N. B.—Instruction in Yogic culture higher as well as lower will be given gratis at the Ās'rama to everyone that earnestly seeks it.

Miscellaneous

AN APPRECIATION

THE NATIONAL MEDICAL COLLEGE MAGAZINE

Bombay, *March 1927.*

Shrimat Kuvalayanandaji (Prof. J. G. Gune) has done a great service to the country by establishing his *Ashrama Kaivalyadhama* for research work in, and the application of the principles of, the system of *Yoga*. The Ashrama is situated at the foot of a hill near Lonavla in a very picturesque locality. Patients of all castes and creeds are treated there, free of charge, by *Asanas*, *Pranayamas* and other Yogic methods. After an experience of 20 years, the Swamiji has been successful in curing 20 diseases; chronic patients taking the treatment well. The most admirable feature of the Ashrama is the research work in Yoga on modern lines. Besides his mastery over the subject of Yoga-Therapy, the Swamiji has a wonderful knowledge of Anatomy, Physiology and allied sciences. By skiagrams, urine examinations and other modern methods, he has demonstrated what effects are produced on the different systems by a particular *Asana*. And it is this knowledge that he makes use of in prescribing *Asanas* for his patients. The results of his research work are published in the *Yoga-Mimansa*, a quarterly from his *Ashrama*.

He has shown to the world that Indian Yoga-Therapy is not a quackery as understood by the Occidental scientists and that scientific experiments have proved the truth of its marvellous effects on the human body. The West has got a great deal to learn from the East. We wish similar *Ashramas* could be established in every city of India.

THE KAIVALYADHĀMA

HOURS OF BUSINESS

Director's Office

8-30 A. M. To 11-30 A. M. 1 P. M. To 1-30 P. M.
5-30 P. M. To 6 P. M.

House Surgeon's Office

8 A. M. To 11 A. M. 4 P. M. To 5 P. M.

Yoga-Mīmāṅsā Office

9 A. M. To 11 A. M. 1 P. M. To 4 P. M.

Demonstrator's Room

8-30 A. M. To 11-30 A. M.

Rana Natavarsingh Clinical Laboratory

8 A. M. To 11 A. M. 4 P. M. To 5 P. M.

Reading Room

8-30 A. M. To 11-30 A. M. 1 P. M. To 6 P. M.

REQUEST TO VISITORS

1 Visitors are requested to get their business done during the office hours only. Prompt and business-like methods are recommended.

2 All inquiries should **first** be made at the Yoga-Mīmāṅsā office which will be working for this purpose upto 6 p. m.

3 The Director is always hard pressed for want of time. Visitors are, therefore, requested to finish their business in the shortest time possible. No interview should exceed 15 minutes. In case a longer interview is desired, the visitor is requested to get a special appointment with the Director for the time he wants.

KUN'JAVANA,
January 1, 1928.

MANAGER, KAIVALYADHĀMA.

RANA NATAVARSINGH CLINICAL LABORATORY

This Laboratory was started in October 1926 and has been associated with the royal name of H. H. The Maharaja Rana Saheb of Porbandar, with his consent, out of gratitude for the patronage His Highness has been graciously giving to the Ās'rama. It is directly in the charge of the House Surgeon of the Ās'rama, Dr. B. M. KADKOL, M. B. B. S., Ophthalmologist and Bacteriologist. Physical, chemical and microscopic tests are instituted in this Laboratory and are offered gratis to everyone presenting himself for clinical examination.

Although this Laboratory is primarily meant for the indoor and outdoor patients of the Ās'rama, it has been thrown open to the general public, also free of charge. It is not binding upon persons presenting themselves for examination from outside to follow the Yogic treatment. They are free to place themselves under any medical man outside the Ās'rama for whatever treatment they like.

HOURS OF ATTENDANCE

8 A. M. To 11 A. M. **4 P. M. To 5 P. M.**

N. B.—Work during extra hours will be done only for very urgent cases.

Lonavla,
1-1-1928.

Kuvalayānanda,
DIRECTOR, KAIVALYADHĀMA,

RULES AND REGULATIONS

for

ADMISSION OF STUDENTS TO THE ĀS'RAMA

General

1 No one will be admitted as a student to the Ās'rama that does not come to it for spiritual evolution.

2 A studentship is available at the Ās'rama only to those who look upon Yoga as a means to self-realisation.

3 No male* below the age of puberty and no female* of whatever description will be admitted to the Ās'rama as a student.

4 Moral excellence is an absolutely necessary qualification for being admitted to a studentship in the Ās'rama.

5 No one that is suffering from a serious defect in his body or brain will be admitted to the Ās'rama as a student.

6 Students who are still under the guardianship of an elderly person shall not be admitted to the Ās'rama without the consent of their guardians.

7 Admission as students will be granted only to those who are either known to some one of the present inmates of the Ās'rama, or to those who can produce satisfactory references from some respectable person of their place.

8 A probationary period of two to six months according to the discretion of the Director, is compulsory for everyone before he is confirmed in his studentship.

9 Students when admitted will have to obey the discipline of the Ās'rama in every detail.

10 Even a day's absence without leave from the Ās'rama will be considered a serious breach of discipline.

---

* Howsoever anxious we may be to provide for the Yogic instruction of both these classes of candidates, our present circumstances put the thing practically out of the question.

11 This or any other serious breach of discipline will entail an immediate expulsion from the Ās'rama.

12 There are three types of studentships instituted in the Ās'rama : (1) Short Period Paying Studentships; (2) Short Period Working Studentships & (3) Permanent Studentships.*

13 No student falling under any of these categories will be charged any fees for Yogic instruction which will ever be given absolutely gratis.

14 Persons losing their studentship not for any serious breach of discipline, are not precluded from applying for a studentship again.

15 First two types of studentships are available even to married persons provided they undertake to follow the Yogic code of sex morality. The last type is open to celibates only.

Short Period Paying Studentships

16 Any one that satisfies the general conditions and undertakes to pay 35 rupees in advance every month for his actual expenses, will be admitted to the Ās'rama for a Short Period Paying Studentship. The Director, however, reserves to himself the right of refusing admission to candidates and is not bound to explain reasons for such a refusal.

17 Short Period Paying Studentships are available for a minimum period of six months and a maximum period of six years only.

18 Should a candidate wish to stay in the Ās'rama for a period less than six months or more than six years, he should do so either as a Visitor or as a Permanent Student respectively.

19 Not more than two months' leave will be granted to a student in a year, every time absence being allowed strictly on grounds of emergency.

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* Another type of Permanent Studentship is yet to be instituted, rules and regulations concerning which will be published later on.

Short Period Working Studentships

20 Candidates that satisfy the general conditions but are not in a position to pay or being in a position do not wish to do so, may be given Short Period Working Studentships in the Ās'rama, provided they undertake to do such work in the Ās'rama as may be assigned to them from time to time by the Director or in the absence of the Director by his representative.

21 The character and amount of work will be such as will not interfere with the Yogic practices of such students. But in times of emergency they are expected voluntarily to look to the interest of the Ās'rama even at some sacrifice of their Yogic studies, such additional work being sure to help them in their spiritual evolution.

22 Candidates to be admitted to this class must not only be very sound in body and mind, but must possess intense hankering for spiritual evolution through Yogic life.

23 No candidate will get a Working Studentship at the Ās'rama if he has completed his thirtieth year. The younger the candidate the more preferable he will be.

24 No candidate that has directly to shoulder any family responsibilities will be admitted to this class of studentship.

25 The Ās'rama will be responsible not only for the boarding and lodging of the working students during their stay at the Ās'rama, but also for the satisfaction of their ordinary wants as students of Yoga. Should a student, however, incur expenses even in the performance of his legitimate duties in other capacities, he should make his own arrangements to defray them.

26 Not more than one month's leave will be granted to a student in a year, every time absence being allowed, strictly on grounds of emergency.

27 Working Studentships are available only for a minimum period of four years.

28 Students of this class must offer themselves as subjects for any Yogic experimentation that may be conducted on behalf of the Ās'rama.

Permanent Studentships

29 Permanent Studentships are available only to those that want to make Yoga their life-work, completely identifying themselves with the Ās'rama and its activities in the Yogic field.

30 Only those celibates that are from sixteen to twenty years of age and that have full confidence in their capacity to continue their chaste celibacy to the thirty-sixth year of their life, will be admitted to this class.

31 Any family tie that would disturb an exclusive Yogic life will constitute a disqualification for a candidate of this class.

32 Permanent Studentships will be available only to those that have a special aptitude for Yogic culture.

33 The Ās'rama undertakes to satisfy all legitimate needs of a permanent student while he is attached to the Ās'rama.

34 After reaching a particular level of spiritual evolution, a permanent student will be admitted to a certain type of membership* in the Ās'rama, securing for him economic independence within the limits of the Ās'rama itself.

35 After the completion of his thirty-sixth year, a permanent student is free to choose whatever walk of life he likes.

Lonavla,
1-1-1928.

Kuvalayānanda,
DIRECTOR, KAIVALYADHĀMA.

* This is yet to be instituted, but a rough idea about it can be had from the Director even now. It will carry with it certain rights giving the member a vote in the management of his particular department.

RULES AND REGULATIONS
for
PATIENTS & VISITORS

1 It is desirable for every gentleman that comes to stay in the Ās'rama even for a day to have his own bedding.

2 Being a hill-station Lonavla is generally cool throughout the year. It is desirable, therefore, for every one coming to the Ās'rama to have sufficient warm clothing with him.

3 As Lonavla records an average rainfall of 175 inches per year, practically all therapeutical work is suspended from the beginning of July to the middle of September. Patients are, therefore, requested not to venture an expedition to this place during the months noted above.

4 To avoid inconvenience to himself and to the management of the Ās'rama, it is desirable that an intending guest should send beforehand precise information regarding the time of his arrival and the probable period of his stay. If any special arrangements of food, etc. are necessary the facts should be clearly intimated.

5 The Ās'rama is strictly for vegetarianism. No non-vegetarian food or tonic would be allowed within the limits of the Ās'rama.

6 Tea and smoke are entirely prohibited within the precincts of the institution.

7 It is desirable that every gentleman coming to the Ās'rama should, as far as possible, conform to the discipline of this place. No unholy act or word should disturb the peace of the Ās'rama.

8 Boarding and lodging are given free of charge, for the first two days, to every one coming to the Ās'rama. Should any one overstay this period, he is charged rupees 45

per month from the date of his arrival for his actual expenses. These charges should be paid in advance.

9 The servants of the Ās'rama look to the ordinary needs of a patient or a visitor. Should anyone want special menial attendance, he must bring his own servant who will be charged for his actual expenses as well as his master.

10 The concession for the first two days is general. Should a gentleman, however, wish to pay even for these days, the money will be thankfully accepted.

11 No concession can be allowed to anybody absenting himself from the Ās'rama for a day or two. If, however, this period exceeds two days, he will be charged only eight annas per day for the period of his absence, provided he intimates the authorities beforehand.

12 Persons intending to leave the Ās'rama should kindly intimate beforehand the time of their departure.

13 The Ās'rama is being conducted with a religious sentiment. The management is, therefore, always anxious not to be mercenary. Gentlemen coming to the Ās'rama are requested to appreciate this attitude and not to introduce any unpleasant monetary discussions in their dealings with the authorities.

14 The Ās'rama stands for Yoga and Yoga alone. It is hoped, therefore, that the facilities given here will not be used for any other purpose by looking upon the institution either as a general sanitarium or health home.

15 No fees are charged for Yogic instruction.

16 All Yogic treatment and consultation is given gratis.

17 The Ās'rama undertakes to treat only chronic patients who are not confined to bed. If, however, any acute symptoms develop after a patient is admitted to the Ās'rama, he will get competent medical advise and attend-

ance quite gratis, but will have to pay a moderate charge for the treatment he receives.

18 There is no accommodation for females. They may, however, come for a few hours for consultation and also for instruction if so advised.

NOTE—

Lonavla is a big railway station on the main line of the G. I. P. Railway running from Bombay to Poona some eighty miles away from the former. The Ās'rama is situated at a distance of a little more than a mile from the station. Conveyances are always available at the station by day time. Should a stranger, however, wish to walk down the distance, he can very easily do it, first by inquiring for the Bombay Poona Road and then by tracing the Ās'rama with the help of the signboards which are placed along the said road at convenient distances. Failure to succeed in this enterprise should direct the pedestrian to the local Post Office for more exact and detailed information.

Lonavla,
1-1-1928.

MANAGER,
KAIVALYADHĀMA.

DISEASES TREATED AT THE ÁS'RAMA

1 *Constipation.*
2 *Dyspepsia.*
3 *Head-ache.*
4 *Piles.*
5 *Heart-disease (functional).*
6 *Neuralgia.*
7 *Diabetes.*
8 *Hysteria.*
9 *Consumption.*
10 *Obesity.*
11 *Sterility (certain types).*
12 *Impotence.*
13 *Appendicitis, &c.*

OUR LIST OF EXCHANGES

INDIAN

ANNALS OF THE BHANDARKAR INSTITUTE, *The Bhandarkar Oriental Research Institute, Poona City.*

CURRENT THOUGHT, *18, Pycrofts Road, Triplicane, Madras, S. E.*

EPIGRAPHIA INDO-MOSLEMICA, *Director General of Archæology in India, Simla.*

INDIAN JOURNAL OF PSYCHOLOGY, *92, Upper Circular Road, Calcutta.*

INDIAN MEDICAL RECORD, *2, Horokumar Tagore Square, Corporation Srteet, East Calcutta.*

JOURNAL OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY, *Town Hall, Bombay.*

JOURNAL OF INDIAN HISTORY, *'Shri Venkatesh Vilas', Nadu Street, Mylapore, Madras.*

PRABUDDHA BHARATA, *182, Muktaram Babu Street, Calcutta.*

PREMA, *Premayatana Ashrama, Tungabhadra, M. S. M. Rly.*

REPORT OF THE ARCHÆOLOGICAL DEPARTMENT OF H. E. H. THE NIZAM'S DOMINIONS, *Hydrabad, Deccan.*

THE ADVERTISER, *Baroda.*

THE ALANKARA & GURUKULA SAMACHARA, *Gurnkula-Kangri Bijnor.*

THE BHISHAGVILASA, *Court Lane, Ahmednagar.*

THE BOMBAY CHRONICLE, *Hari Building, Old Custom House Road, Bombay.*

THE CHITRAMAYA JAGAT, *Chitrashala Press, 1026, Sadashiv Peth, Poona City.*

THE JAINA GAZETTE, *9, Ammen Koil Street, George Town, Madras.*

THE JAYAKARNATAKA, *Dharwar.*

THE JOURNAL OF AYURVEDA, *2, Horokumar Tagore Square, Corporation Street, East Calcutta.*

THE KALPAKA, *The Latent Light Culture, Tinnevelly, S. India.*

THE KESARI, *Gaikavad Wada, 568, Narayan Peth, Poona City.*

THE MAHARASHTRA, *100, Fadnispura, Circle No. 7, Nagpur City.*

THE MAHRATTA, *Gaikavad Wada, 568, Narayan Peth, Poona City.*

THE MODERN REVIEW, *91, Upper Circular Road, Calcutta.*

THE NAVAKALA, *6, Khatav Makanji's Wadi, Girgaon, Bombay.*

THE PRABODHA, *Lane No. 1, House No. 5, Dhulia.*

THE PROGRESS OF EDUCATION, *The Aryabhushana Press Poona City.*

THE PHILOSOPHICAL QUARTERLY, *Indian Institute of Philosophy, Amalner, E. Khandesh.*

THE PURATATVA, *Gujrat Puratatva Mandira, Ahmedabad.*

THE PURUSHARTHA, *Svadhyaya Mandala, Aundh, Satara.*

THE QUARTERLY JOURNAL OF THE MYTHIC SOCIETY, *The Mythic Society, Bangalore.*

THE QUARTERLY JOURNAL OF THE ANDHRA HISTORICAL RESEARCH SOCIETY, *The Andhra Historical Research Society, Rajah, mundry.*

THE SWARAJYA, *563, Sadashiva Peth, Poona City.*

THE THEOSOPHIST, *The Theosophical publishing House, Adyar, Madras.*

THE VAIDIK-DHARMA, *Svadhyaya Mandala, Aundh, Satara.*

THE VEDIC MAGAZINE & GURUKULA SAMACHARA, *Gurudatta Bhavana, Lahore.*

THE VIDYASEVAKA, *Jnanakosha Press, Sadashiv Peth, Poona City.*

THE VISVA-BHARATI QUARTERLY, *53, Old Ballygunge 1st Lane-Calcutta.*

THE VIVIDHAJNANAVISTARA, *364, Thakurdwar, Bombay No. 2.*

WELFARE, *91, Upper Circular Road, Calcutta.*

FOREIGN

GOOD HEALTH, *The Good Health Publishing Company, Battle Creek, Michigan, U. S. A.*

NATURE'S PATH, *124, East 41st Street, New York, U. S. A.*

NATUROPATH, *124, East 41st Street, New York, U. S. A.*

THE EASTERN BUDDHIST, *The Eastern Buddhist Society, Kyoto, Japan.*

THE JOURNAL OF THE ROYAL SANITARY INSTITUTE, *90, Buckingham Palace Road, London, S. W. I.*

THE MONIST, *The Open Court Publishing Company, Wieboldt Hall, 339, East Chicago Avenue, Chicago, U. S. A.*

THE OCCULT REVIEW, *Paternoster House. London E. C. 4.*

THE OPEN COURT, *The Open Court Publishing Company, Wieboldt Hall, 339, Eastchicago Avenue, Chicago, U. S. A.*

THE QUEST, *The Quest Society, 27, Clareville Grove. London S. W. 7.*

तदेकोऽवशिष्टः शिवः केवलोऽहम् ।
I alone persist : Blissful : Absolute.

ॐ

सोऽहम् ।

Yoga-Mīmāṅsā

EDITED BY

S'RĪMAT KUVALAYĀNANDA

(J. G. Guṇe)

April 1928

Vol. III

No. 2

KAIVALYADHĀMA

Post-Lonavla

(Bombay-India)

सर्वं खल्विदं ब्रह्म ।
All this is, indeed, Brahman.

नेह नानास्ति किञ्चन ।
There is nothing here apart from it.

शरीरमाद्यं खलु धर्मसाधनम् ।
Surely Health is the primary requisite of spiritual life.

Printed by A. S. Gokhale, at the Vijaya Press, 570 Shaniwar Peth, Poona No. 2, and Published by S'rīmat Kuvalayānanda(J. G. Guṇe), at Kun'javana (904 Valvana), Lonavla.

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सोऽहम् ।

YOGA-MĪMĀṄSĀ

VOL. III APRIL, 1928. NO 2.

Editorial Notes

MAY the Maker of all make this journal a success Blessed is the name of the Lord. May He bless the workers of the Ās'rama with a happy and prosperous career as servants of the world which is only the Lord Himself objectified. May He, that has created us in His infinite wisdom, lead us to the light that is beyond all darkness.

* * *

OUR article on the Rationale of Yogic Poses has been concluded in this issue. Although written with a view to explain the physiological philosophy of the poses, it covers the whole ground of Yogic physical culture. A study of this article is almost indispensable to everyone who wants to understand the physiological and therapeutical background of the Yogic exercises being discussed in this journal.

* * *

WE have promised our readers to discuss the technique of Prāṇāyāma in this volume. In order to do it correctly we had to examine the current anatomical and physiological notions about the respiratory apparatus. While engaged in this task, we discovered that the modern ideas regarding

the actions of the diaphragm gave occasion to suspect their accuracy. Hence we tried several experiments with the diaphragm and also with the ribs with whose actions the actions of the diaphragm are vitally connected. In the last issue of this journal we have partly discussed these actions with the help of the evidence that we had already got in our possession. In this issue some of the special experiments that we undertook for investigating the diaphragmatic actions have been given. We have not, however, given any additional discussion of the subject in the present issue, because we want to publish some more experiments pertinent to the problem which are necessary to enable our readers to follow our argument in detail and to judge of the accuracy of our statements in the light of the evidence adduced. The remaining experiments and the additional discussion will be given in the next number in the Scientific Section, and in the same number we shall also start giving in detail the technique of Prāṇāyāma.

* * *

TO enable our non-medical readers to follow the instruction in Prāṇāyāma with scientific accuracy, and also to help them to grasp the physiological value of the detailed technique of these exercises, we have started giving an exhaustive note on respiration. Needless to say that the treatment in the note follows the Prāṇāyāmic point of view. We have strongly to recommend our readers to digest this note, so that they will clearly understand how to avoid the many pitfalls that lie in the way of a student of Prāṇāyāma.

* * *

WE have to draw special attention of our readers to the caution given on pp. 151-52 of this issue. As everything there is stated in clear terms, we do not wish to say anything more about it in these notes.

* * *

THE articles on Brahmacharya and Freedom from Emotions will show how overwhelmingly important the mental factor is in Yogic culture. For those who wish to take to Yoga for spiritual progress, the mental discipline is most essential. We might make it clear to our readers that none can hope to achieve any spiritual success unless he puts an effective control upon his mind. Yogic exercises will be found of incalculable value in schooling one's mind. But the student has to exercise perpetual vigilance upon his mind even when he is not actually engaged in doing his Yogic exercises. Then and then alone he can hope to discipline his mind and reap the full advantage of the exercises he may be doing.

* * *

IT is a matter of great pleasure to note the attention which the Ās'rama has succeeded in claiming from two Provincial Governments, the Government of Bombay and the Government of the United Provinces. The Government of Bombay have appointed us to work on the Committee constituted for investigating the problem of compulsory physical training in the schools of this presidency. As the deliberations of this Committee are yet in progress, we do not wish to say anything today regarding its work. But when its report will be out, we shall be happy to make a statement in these pages regarding the place Yogic physical culture is given in the general scheme of the Committee's recommendations.

* * *

FROM p. 155 it will be seen that last summer the U. P. Government deputed their Deputy Director of Public Health and Hygiene to the Ās'rama in order to report on the possibility of the Yogic exercises being introduced in the U. P. schools. We have reason to believe that the report of the officer thus deputed, has been very favourable and that his recommendations are receiving the attention of the U. P. Government.

* * *

A REFERENCE to p. 157 will show an additional activity undertaken by the Kaivalyadhāma. A series of lectures to be delivered by leaders of Indian thought is arranged for the benefit of the inmates of the As'rama. With a view to extend the utility of these lectures the Director proposes to publish them in suitable volumes. We refer our readers to p. 157 for further information.

* * *

LASTLY we have to draw our readers' attention to the appreciation given at the end of this number. The periodical Lokas'ikshana in which the appreciation appears, is a valuable monthly in Marāthī. Even in something like less than year, it has attained a place of esteem and influence among the educated Māhārāshtrīyas. Our best thanks are due to its learned editor for reviewing our journal in his valuable magazine.

The Scientific Section

X-RAY EXPERIMENTS ON THE DIAPHRAGM AND THE RIBS

THE actions of the diaphragm as described by anatomists such as Gray and others on the one hand and the physical culturist Mr. Muller on the other, were thought to be problematical. We started investigating the question with the help of the Yogic exercises and tried barometrical experiments on the intra-gastric pressure which have been recorded in the last issue. In the light of the conclusions reached in these experiments and with the help of some radiographic evidence that we already had in our possession, we tried to make out a few points in our article on the diaphragm and the ribs published in the last issue.

The X-Ray experiments given in this number were undertaken to collect additional evidence for solving the problem of diaphragmatic actions satisfactorily.

The evidence gathered from these experiments supports the position we took in this connection in our article that appeared in the last issue of this journal. We can clearly see that the ribs can be raised without any help of the diaphragm.

It may be urged with some show of truth that the actions studied in the following experiments are *abnormal* and hence the findings would not hold good in the case of normal actions. In the next issue we shall publish evidence bearing on actions falling within normal range ; and then discuss the problem at length in the article on the diaphragm and the ribs which will continue from the last number.

Experiment I

OBJECTS OF THE EXPERIMENT :—

One of the objects of this experiment was to study the position of the diaphragm after a forcible deep expiration, with a view to contrast it with its position in Uḍḍiyāna and the three different aspects of Nauli. Another object was to note the position of the ribs under the same circumstances, with a view to compare it with their position in Uḍḍiyāna and the three different aspects of Nauli. The third object was to observe the relative positions of the diaphragm and the ribs after a forcible deep expiration, with a view to compare them with the relative positions assumed by these organs during Uḍḍiyāna and the three aspects of Nauli.

PREPARATION OF THE SUBJECT :—

The subject was a young man of twenty-seven. He was quite healthy and had mastered not only Uḍḍiyāna and Nauli but also the different methods of Prāṇāyāma. On the noon previous to the day of experiment, he had had his usual meal. In the evening he did not take even a cup of milk and retired without any laxative. In the morning at about 6 o'clock he had his colon flushed with four pints of tepid water. The experiment started at about 9 a.m. As the experiment was to be made with the diaphragm and the ribs, no other preparation was necessary.

EXPERIMENT PROPER :—

For being skiagraphed the subject was made to sit on a stool, with his legs resting on the cross-bars of the same stool below. The X-Ray plate was fixed on a stand in front of his chest and abdomen quite close to these parts. The tube was arranged at the back of the subject. The distances between the plate and the subject, and the subject and the tube, were maintained uniform throughout this and the four experiments that follow.

The subject then practised a forcible deep expiration by fully contracting his abdominal muscles. The radiograph taken in this position has been shown in Fig. XXII. Fig. XXIII gives the line drawing of the same.

NOTE—

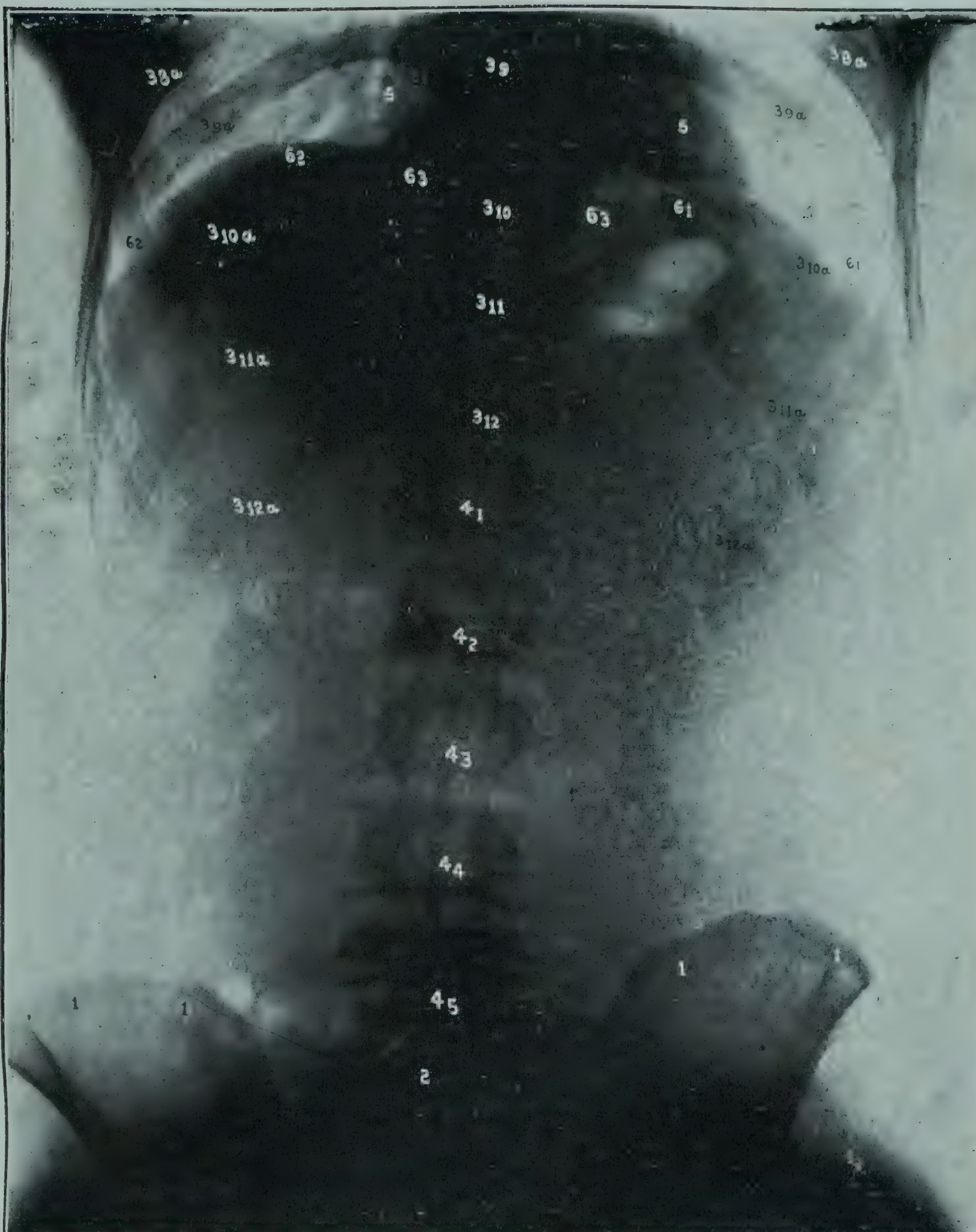
The radiographs printed in this issue were all originally 15″ × 12″. They have been subsequently reduced to suit the size of this journal.

REFERENCES TO RADIOGRAPH V

1 The Iliac Bones.
2 The Sacrum.
38a The Eighth Ribs.
39 The Ninth Dorsal.
39a The Ninth Ribs.
310 The Ninth Dorsal.
310a The Tenth Ribs.
311 The Eleventh Dorsal.
311a The Eleventh Ribs.
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312a The Twelfth Ribs.
41 The First Lumber.
42, 43, 44, 45 The Successive Lumber Vertebraæ upto the Fifth.
5 The Heart.
61 The Upper Margin of the Left Dome of the Diaphragm.
61 The Upper Margin of the Right Dome of the Diaphragm.
63 The Central Tendon.

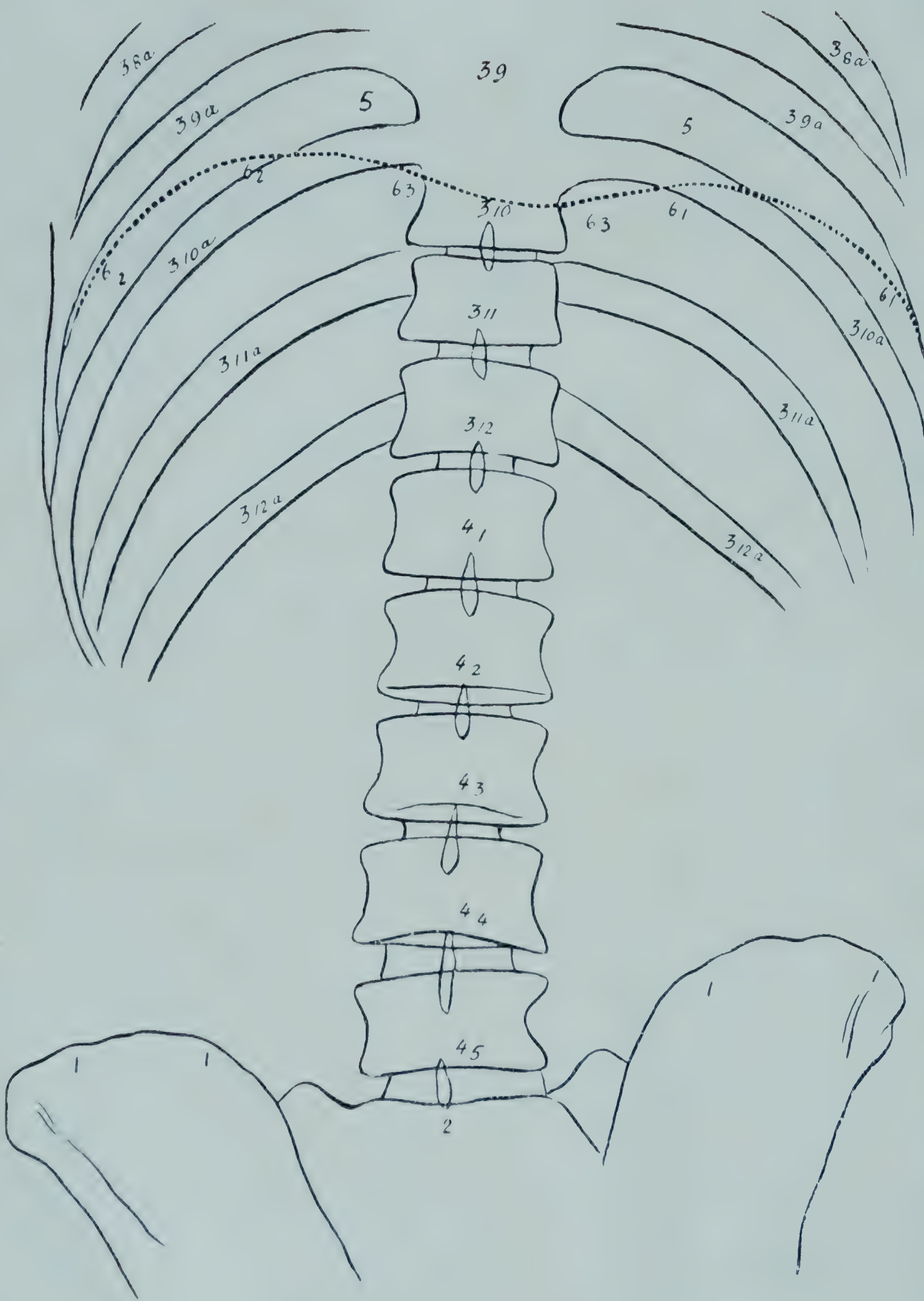
Fig. XXII

Radiograph V



Position of the Diaphragm and the Ribs
after
A Forcible Deep Expiration.

Fig. XXIII



Line Drawing of Radiograph V

REFERENCES TO RADIOGRAPH V

1 The Iliac Bones.

2 The Sacrum.

3_{8a} The Eighth Ribs.

3_{9} The Ninth Dorsal.

3_{9a} The Ninth Ribs.

3_{10} The Tenth Dorsal.

3_{10a} The Tenth Ribs.

3_{11} The Eleventh Dorsal.

3_{11a} The Eleventh Ribs.

3_{12} The Twelfth Dorsal.

3_{12a} The Twelfth Ribs.

4_{1} The First Lumbar.

4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.

5 The Heart.

6_{1} The Upper Margin of the Left Dome of the Diaphragm.

6_{2} The Upper Margin of the Right Dome of the Diaphragm.

6_{3} The Central Tendon.

N.B.—The thick dotted line indicates the diaphragm in the accompanying figure.

POINTS OF STUDY :—

1 —(a) The radiograph covers the upper parts of the iliac bones and the sacrum.

(b) All the lumbar vertebræ are clearly visible.

(c) The last four dorsal vertebræ are also to be seen, the lower two being somewhat distinct and the upper two being shadowed by the diaphragm and the heart.

(d) The twelfth, the eleventh and the tenth ribs have been completely covered by the radiograph. Parts of the ninth and eighth ribs are also visible.

(e) Only small portions of the external margins of the heart are distinctly observable. The upper part of the heart has been left out of the picture and the shadows of the lower part have been mixed up with those of the diaphragm.

2 —(a) The upper border of the diaphragm can be clearly seen.

(b) The right dome rises to the level of the upper border of the tenth dorsal.

(c) The shadows of the right half of the diaphragm almost touch the ninth rib.

3 —(a) The left dome of the diaphragm rises only to the level of the middle of the tenth dorsal.

(b) The shadows of the left half of the diaphragm extend a little beyond a part of the tenth rib, but lie quite clear of the ninth.

(c) The right dome rises higher than the left.

4 —(a) The central tendon lies across the tenth dorsal and shows the usual downward depression towards the left.

(b) Although the middle of the central tendon is not to be clearly seen, its position is visibly indicated by the shadows of its extremeties.

5 — The distance between the two upper corners of the first lumbar vertebra is 4·8 cm.

6 —(a) The distance between the tenth ribs at the level of the upper border of the first lumbar vertebra is 23·2 cm.

(b) The distance between the free ends of the eleventh ribs is 21·5 cm.

7 — The shadows on the two sides of the lumbar region of the spine are thrown by the contracted abdominal muscles.

8 —(a) The white spot crossing the eleventh left rib indicates accumulation of gases in the colon at the splenic flexure.

(b) Similar but clearer whiteness to be seen on the two sides of the lumbar spine in the next radiograph, shows similar accumulation of gases in the abdomen due to the negative pressure created therein on account of Uḍḍiyāna.

9 — The convexity of the two diaphragmatic domes should be carefully marked here so that it can be compared with their convexity in the other experiments that follow.

Experiment II

OBJECTS OF THE EXPERIMENT :—

One of the objects of this experiment was to study the position of the diaphragm during Uḍḍiyāna with a view to contrast it with its position observed in the last experiment after a forcible deep expiration and during the three different aspects of Nauli to be studied in the next three experiments. Another object was to note the position of the ribs during Uḍḍiyāna, with a view to compare it with their position after a forcible deep expiration and during the three different aspects of Nauli. The third object was to observe the relative positions of the diaphragm and the ribs during Uḍḍiyāna, with a view to compare them with the relative positions assumed by these organs after a forcible deep expiration and during the three aspects of Nauli.

PREPARATION OF THE SUBJECT :—

The same subject in the last experiment was immediately taken up for this.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. After a forcible deep expiration as in the last experiment, the subject practised Uḍḍiyāna. The radiograph taken while Uḍḍiyāna was being maintained is produced in Fig. XXIV. Fig. XXV gives the line drawing of the same.

Fig. XXIV Radiograph VI



Position of the Diaphragm and the Ribs
during
Uḍḍiyāna.

References to Radiograph VI

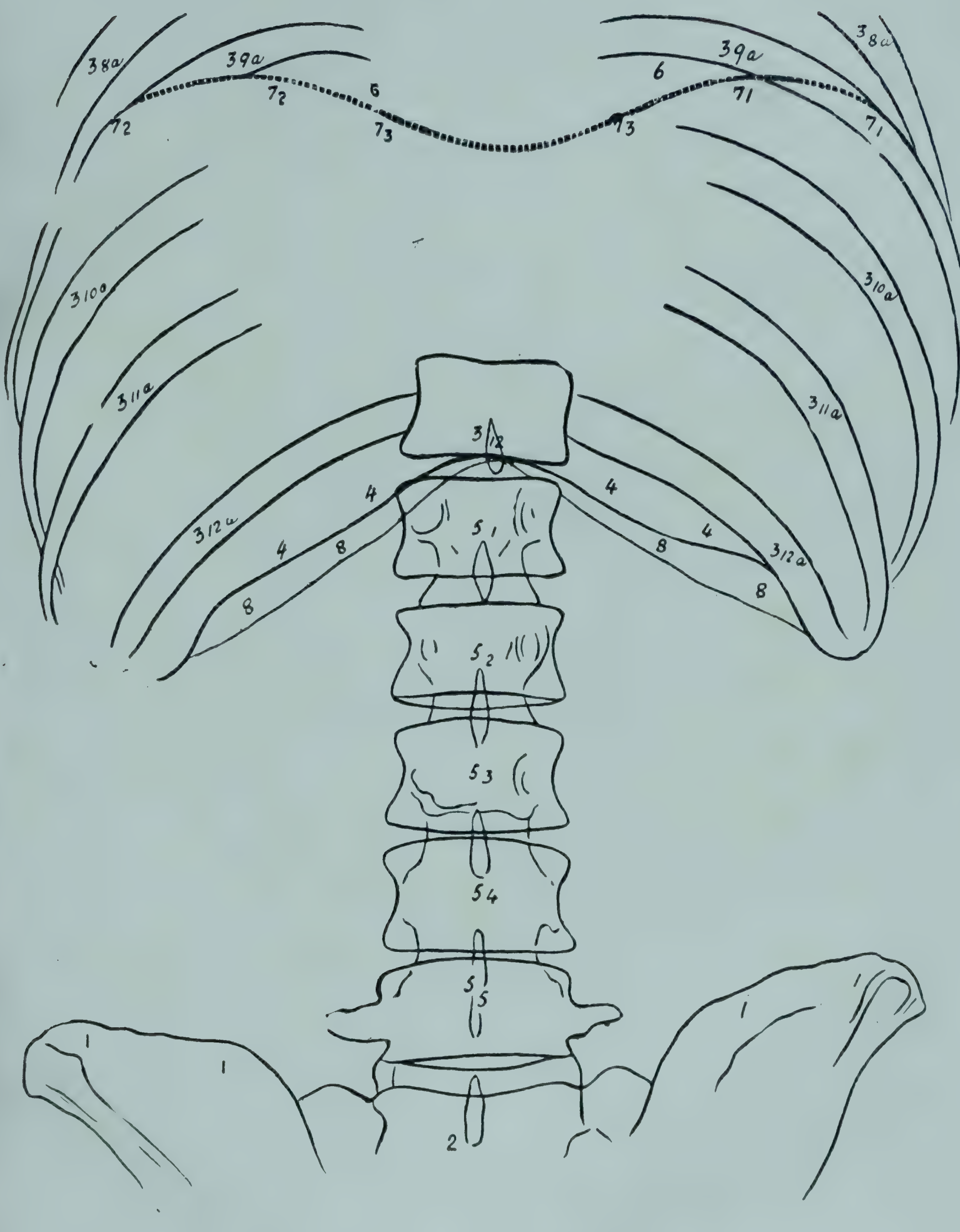
1 The Iliac Bones.
2 The Sacrum.
3_{8a} The Eighth Ribs.
3_{9a} The Ninth Ribs.
3_{10a} The Tenth Ribs.
3_{11a} The Eleventh Ribs.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4 The Costal Margins.
5_{1} The First Lumbar.
5_{2}, 5_{3}, 5_{4}, 5_{5} The Successive Lumbar Vertebræ upto the Fifth.
6 The Heart.
7_{1} The Upper Margin of the Left Dome of the Diaphragm.
7_{2} The Upper Margin of the Right Dome of the Diaphragm.
7_{3} The Central Tendon.
8 The Lower Margin of Diaphragm.

REFERENCES TO RADIOGRAPH VI

1 The Iliac Bones.
2 The Sacrum.
3_{8a} The Eighth Ribs.
3_{9a} The Ninth Ribs.
3_{10a} The Tenth Ribs.
3_{11a} The Eleventh Ribs.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4 The Costal Margins.
5_1 The First Lumbar.
5_2, 5_3, 5_4, 5_5 The Successive Lumbar Vertebræ upto the Fifth.
6 The Heart.
7_1 The Upper Margin of the Left Dome of the Diaphragm.
7_2 The Upper Margin of the Right Dome of the Diaphragm.
7_3 The Central Tendon.
8 The Lower Margin of the Diaphragm.

N.B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XXV



Line Drawing of Radiograph VI

POINTS OF STUDY :—

1 —(a) The radiograph covers the upper parts of the iliac bones and the sacrum.

(b) All the lumbar vertebræ are clearly visible.

(c) The twelfth dorsal can be dimly seen, but the next upper three, although they are covered by the plate, are shadowed by the diaphragm and the heart.

(d) The twelfth ribs alone can be entirely observed although their shadows are faint. The eleventh to eighth ribs are seen only in parts.

(e) Only small portions of the external margins of the heart are distinctly observable. The upper part of the heart has been left out of the picture, and the shadows of the lower part have been mixed up with those of the diaphragm.

(f) The costal margins can be clearly seen.

(g) The lower border of the diaphragm has been distinctly drawn out in the picture.

2 —(a) The two domes of the diaphragm can be clearly seen.

(b) The right dome rises to the level of the upper border of the ninth dorsal. Although the ninth dorsal has been covered by the shadows of the heart here, its position can be inferred from the curves of the ninth ribs. Again the original radiograph is clearer on this point and helps to understand the figure.

(c) This position of the right dome is higher by the full height of the ninth dorsal than its position in the last experiment.

(d) The shadows of the right half of the diaphragm extend beyond the ninth rib and almost touch the eighth.

(e) In the last experiment these shadows only verged on the ninth rib. Hence they are broader in

this picture than in the last, showing the lateral expansion of the diaphragm in Uḍḍiyāna.

3 —(a) The left dome of the diaphragm rises *nearly* as high the right one. Ordinarily and even in extra-ordinary expiration as shown in the last experiment, the level of the left dome is much below that of the right. The present position of about equal height of the two domes is due to Uḍḍiyāna.

(b) In the last experiment the left dome lay as high as the middle of the tenth dorsal whereas here it has risen to the level of the upper border of the ninth, indicating a rise covering the full height of the ninth, the intermediate space between the ninth and the tenth, and half of the tenth dorsal.

(c) The shadows of the left half of the diaphragm extend far beyond the tenth rib and even beyond a part of the ninth. In the previous experiment they did not even touch the ninth rib. This positively shows the lateral expansion[1] of the diaphragm owing to Uḍḍiyana.

4 —(a) The present picture does not allow us to study the position of the central tendon. Its shadows are mixed up with those of the heart and the spinal column. But the original radiograph shows that the central tendon is a trifle above the upper border of the tenth dorsal.

(b) In the previous experiment the central tendon lay across the tenth dorsal crossing the upper half of it. A comparison between that position and the position assumed by the central tendon in this experiment, shows that the same has not risen much higher in Uḍḍiyāna. The rise of the domes is far more remarkable than that of the central tendon.

1 This lateral expansion noticed here as well as in 2 —(c) previously, is only measured in relation to the position of the ribs. When we presently see that the distance between the ribs themselves has become widened, we can immediately realise that the absolute lateral expansion of the diaphragm must be much greater.

5 —(a) The distance between the two upper corners of the first lumbar vertebra is 4·8 cm.

(b) This distance is the same as the distance between these two corners recorded in the last experiment. This fact clearly proves that *at least* at the level of these corners, the distances between the tube and the subject, and also between the subject and the plate, were relatively the same in this experiment as in the last. Hence a comparison between measurements taken at this level would yield correct results.

6 —(a) The distance between the tenth ribs at the level of the upper border of the first lumbar is 26·5 cm. In the last experiment this distance measured only 23·2 cm. This increase of 33 mm. clearly demonstrates a considerable rise of the tenth ribs in Uḍḍiyāna.

(b) The distance between the ends of the eleventh ribs is 23.6 cm. In the previous experiment this distance was noted to be 21.5 cm., showing an increase of 21 mm. in Uḍḍiyāna. This proves that the eleventh ribs also were elevated.

(c) An examination of other ribs included in this and the previous radiographs will show that in Uḍḍiyāna the ribs are raised higher than in the forced expiration.

(d) Sections 2, 3 and 4 of this study go to prove that the diaphragm rises in Uḍḍiyāna. Sections 5 and 6 show that the ribs are elevated in the same action. So the five sections taken together conclusively establish that both the diaphragm and the ribs can be raised simultaneously.

EXPERIMENT III

OBJECTS OF THE EXPERIMENT :—

One of the objects of this experiment was to study the position of the diaphragm during Nauli-Madhyama or the central aspect of Nauli, with a view to contrast it with its position observed in the last two experiments, and during Dakshiṇa-Nauli and Vāma Nauli to be observed in the next two experiments. Another object was to note the position of the ribs during Nauli-Madhyama, with a view to compare it with their position after both a forcible deep expiration and Uḍḍiyāna on the one hand and during Dakshiṇa Nauli and Vāma Nauli on the other.. The third object was to study the relative positions of the diaphragm and the ribs during Nauli-Madhyama, with a view to compare them with the relative positions assumed by these torgans after a forcible deep expiration or Uḍḍiyāna and also during Dakshiṇa Nauli and Vāma Nauli.

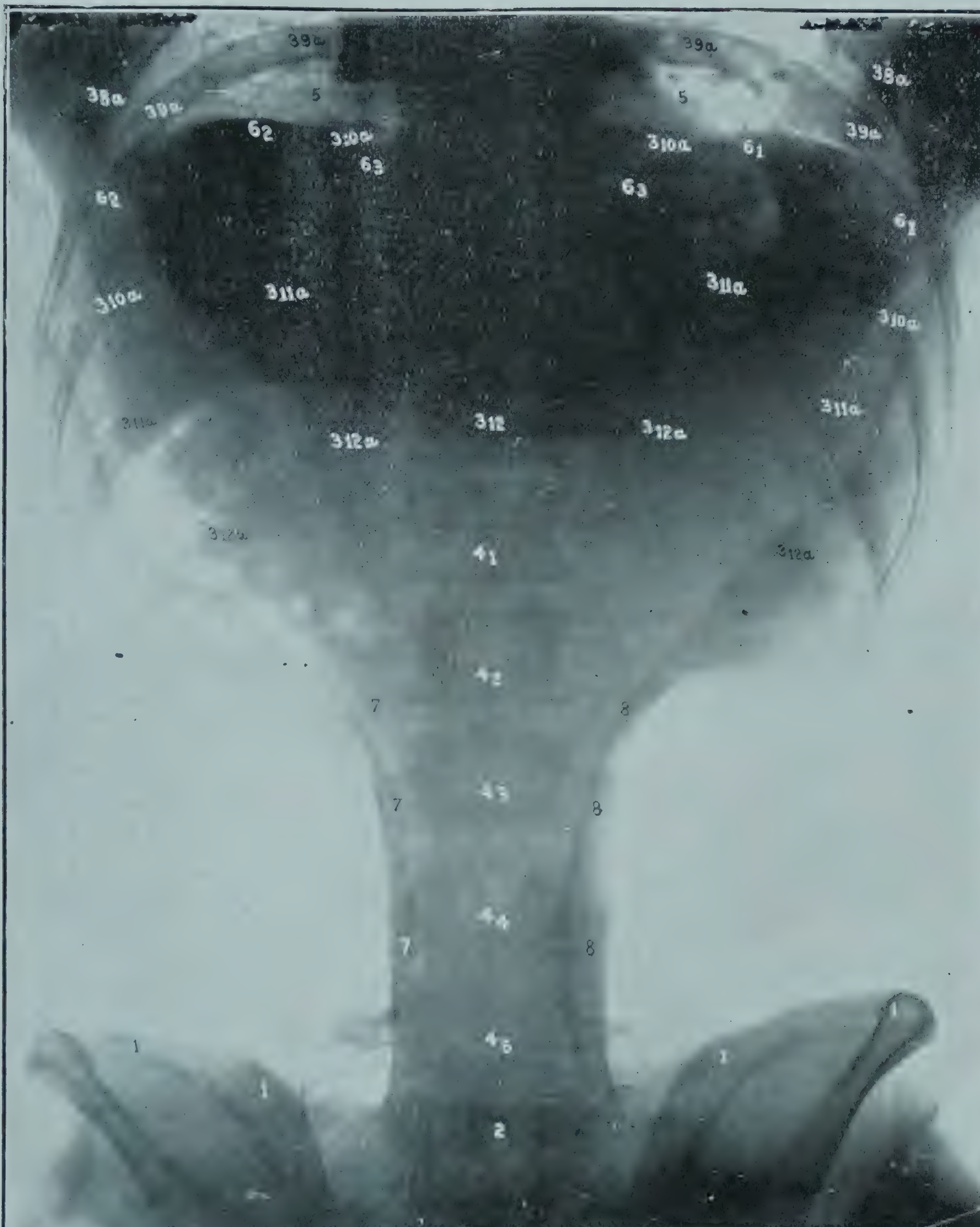
PREPARATION OF THE SUBJECT :—

The same subject as in the last experiment was immediately taken up for this.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. After Uḍḍiyāna, the subject practised Nauli-Madhyama. The radiograph taken while Nauli-Madhyama was being maintained is produced in Fig. XXVI. Fig. XXVII gives the line drawing of the same.

Fig. XXVI Radiograph VII



Position of the Diaphragm and the Ribs
during
Nauli-Madhyama.

REFERENCES TO RADIOGRAPH VII

1 The Iliac Bones.

2 The Sacrum.

3_{8a} The Eighth Ribs.

3_{9a} The Ninth Ribs.

3_{10a} The Tenth Ribs.

3_{11a} The Eleventh Ribs.

3_{12} The Twelfth Dorsal.

3_{12a} The Twelfth Ribs.

4_1 The First Lumbar.

4_2, 4_3, 4_4, 4_5 The Successive Lumbar Vertebræ upto the Fifth.

5 The Heart.

6_1 The Upper Margin of the Left Dome of the Diaphragm.

6_2 The Upper Margin of the Right Dome of the Diaphragm.

6_3 The Central Tendon.

7 The Right Rectus Contracted.

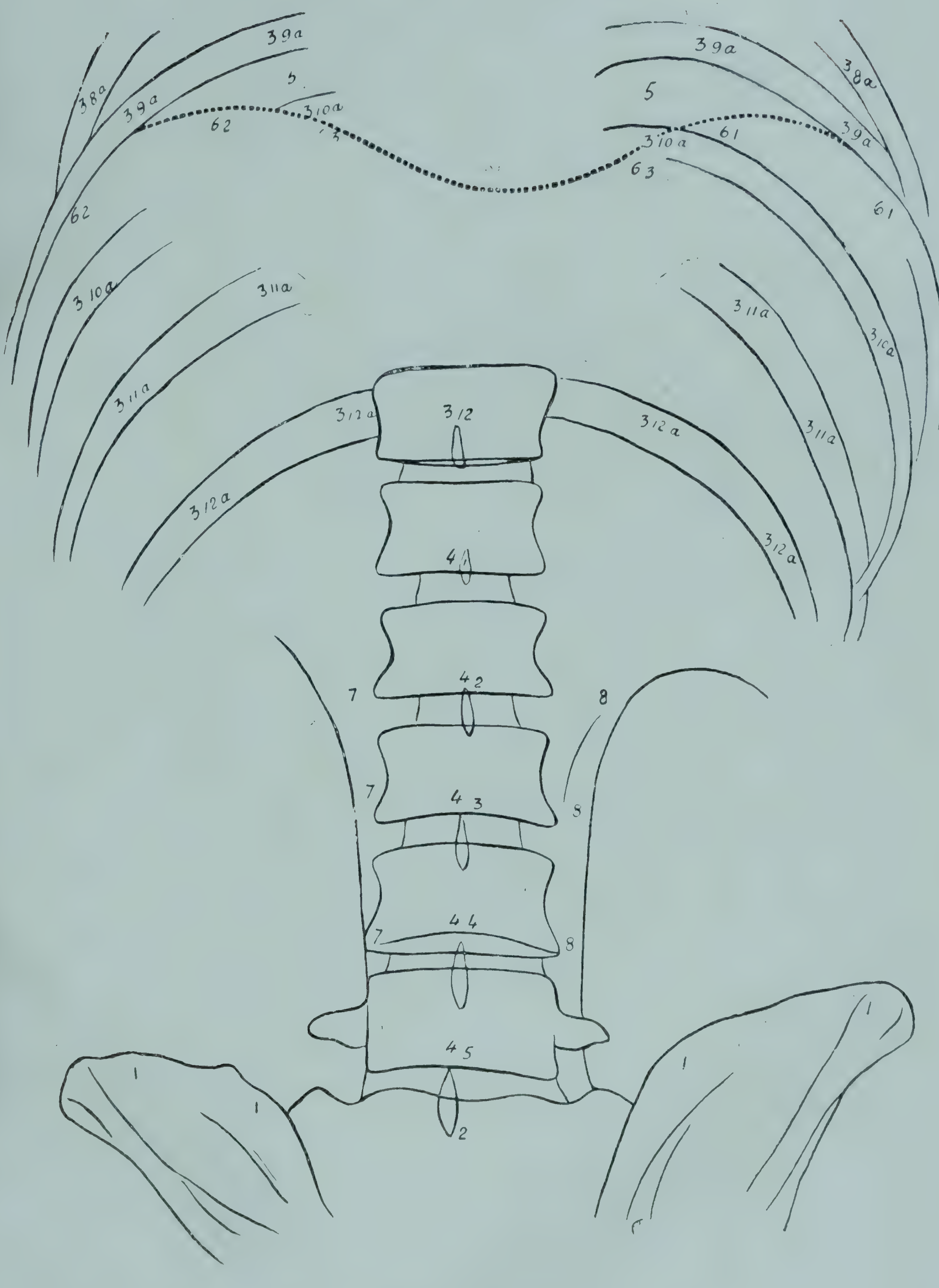
8 The Left Rectus Contracted.

REFERENCES TO RADIOGRAPH VII

1 The Iliac Bones.
2 The Sacrum.
3_{8a} The Eighth Ribs.
3_{9a} The Ninth Ribs.
3_{10a} The Tenth Ribs.
3_{11a} The Eleventh Ribs.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4_{1} The First Lumbar.
4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.
5 The Heart.
6_{1} The Upper Margin of the Left Dome of the Diaphragm.
6_{2} The Upper Margin of the Right Dome of the Diaphragm.
6_{3} The Central Tendon.
7 The Right Rectus Contracted.
8 The Left Rectus Contracted.

N.B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XXVII



Line Drawing of Radiograph VII

POINTS OF STUDY :—

1 — (a), (b), (c), (d), (e) as in Experiment II.

2 —(a) The two domes of the diaphragm can be clearly seen.

(b) The right dome rises a little higher than the level of the upper border of the tenth dorsal. Although the tenth dorsal has been covered by the shadows of the heart here, its position can be inferred from the curves of the tenth ribs.

(c) This position of the right dome is far lower than its position during Uḍḍiyāna as shown in the last experiment; but is nearly the same as in the first experiment after a forcible deep expiration.

(d) The shadows of the right half of the diaphragm encroach upon those of the ninth rib, but do not fully cover them.

(e) During Uḍḍiyāna these shadows crossed the shadows of the ninth ribs and almost touched those of the eighth. That means there is shrinkage in lateral measurement of the diaphragm when one passes from Uḍḍiyāna to Nauli-Madhyama.

3 —(a) The left dome of the diaphragm is slightly lower than the right, but not as lower as in the first experiment. During Uḍḍiyāna the two domes had risen almost to an equal height. This means in Nauli-Madhyama, the normal difference in the heights of the two domes is being recovered.

(b) In Uḍḍiyāna the left dome had risen to the level of the upper border of the ninth dorsal. Here it is in line with the upper border of the tenth. This clearly indicates a fall equal to the height of the ninth dorsal and the intermediate space between the ninth and the tenth.

(c) The shadows of the left half of the diaphragm only touch the inner border of the ninth rib.

In Uḍḍiyāna they had gone beyond a part of this rib. Thus we find that the diaphragm suffers in lateral expansion in going from Uḍḍiyāna to Nauli-Madhyama. It is to be noted, however, that in Nauli-Madhyama the lateral expansion of the diaphragm is greater than in a forcible deep expiration. For in the first experiment the shadows of the left half of the diaphragm were observed to lie quite clear of the ninth rib.

4 —(a) The present picture does not allow us to study the position of the central tendon. Its shadows are mixed up with those of the heart and the spinal column. But the position of the tenth ribs shows that the central tendon is lying across the tenth dorsal rising three-fourths of its height.

(b) In Uḍḍiyāna this central tendon stood a trifle higher than the tenth dorsal. In the forced expiration it crossed the tenth dorsal in the middle. Here it passes across the tenth dorsal at three-fourths of its height. These facts show that the rise and fall of the central tendon has been very small.

5 —(a) The distance between the two upper corners of the first lumbar vertebra is 4. 8 cm.

(b) This distance is the same as the distance between these two corners recorded in the last two experiments. This fact clearly proves that *at least* at the level of these corners, the distances between the tube and the subject, and also between the subject and plate, were relatively the same in this experiment as in the last two. Hence a comparison between measurements taken at this level would yield correct results.

6 —(a) The distance between the tenth ribs at the level of the upper border of the first lumbar is 25. 6 cm. in the plate under examination. In Uḍḍiyāna

the same was 26 . 5 cm. and in the forced expiration it was 23 . 2 cm. That means in Uḍḍiyāna the distance increased by 33 mm., but in Nauli-Madhyama *again* decreased by 9 mm. This increase and decrease show the rise of the ribs in Uḍḍiyāna and subsequent fall in Nauli-Madhyama.

(b) The distance between the ends of the eleventh ribs is 23 . 3 cm. in the present plate. In Uḍḍiyāna the same was noted to be 23 . 6 cm. This trifling decrease of 3 mm. shows that the eleventh ribs are not much affected in going from Uḍḍiyāna to Nauli-Madhyama.

(c) A general examination of other ribs included in this and in the previous radiograph, shows that the ribs are lowered is passing from Uḍḍiyāna to Nauli-Madhyama.

(d) Sections 2, 3 and 4 of this study prove that in Nauli–Madhyama the diaphragm stands lower than in Uḍḍiyāna. Sections 5 and 6 prove the same thing in the case of the ribs. So the five sections considered together prove that both the diaphragm and the ribs can be lowered simultaneously.

7 —(a) The shadows covering the lumbar region of the spine are cast by the abdominal recti that stand vigorously contracted in front of the spine in Nauli-Madhyama.

(b) The fan-shape of those muscles can be clearly seen in the picture.

Experiment IV

OBJECTS OF THE EXPERIMENT :—

One of the objects of this experiment was to study the position of the diaphragm during Dakshiṇa Nauli or the right aspect of Nauli, with a view to contrast it with its position during the other two aspects of the same exercise. Another object was to note the position of the ribs during Dakshiṇa Nauli, with a view to compare it with their position in Ṅauli-Madhyama and Vāma Nauli. The third object was to study the relative positions of the diaphragm and the ribs, with a view to compare them with the relative positions assumed by these organs either in the central aspect or in the left aspect of Nauli.

PREPARATION OF THE SUBJECT :—

This and the next experiment were performed on a day different from that of the last three experiments. The subject on whom these experiments were tried continued to be the same, however. The method of preparation also was identical with that adopted in the previous cases.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the last three experiments. It will be noted, however, that owing to the unequal contraction of the right and left recti of the abdomen, the spine has experienced a side bent. After practising Nauli-Madhyama, the subject relaxed the left rectus, trying to maintain the right one in vigorous contraction. The radiograph taken in this condition is shown in Fig. XXVIII. Fig. XXIX gives the the line drawing of the same.

Fig. XXVIII Radiograph VIII



Position of the Diaphragm and the Ribs
during
Dakshiṇa Nauli.

REFERENCES TO RADIOGRAPH VIII

1 The Iliac Bones.

2 The Sacrum.

3_{8a} The Eighth Ribs.

3_{9a} The Ninth Ribs.

3_{10a} The Tenth Ribs.

3_{11a} The Eleventh Ribs.

3_{12} The Twelfth Dorsal.

3_{12a} The Twelfth Ribs.

4_{1} The First Lumbar.

4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.

5 The Heart.

6_{1} The Upper Margin of the Left Dome of the Diaphragm.

6_{2} The Upper Margin of the Right Dome of the Diaphragm.

6_{3} The Central Tendon.

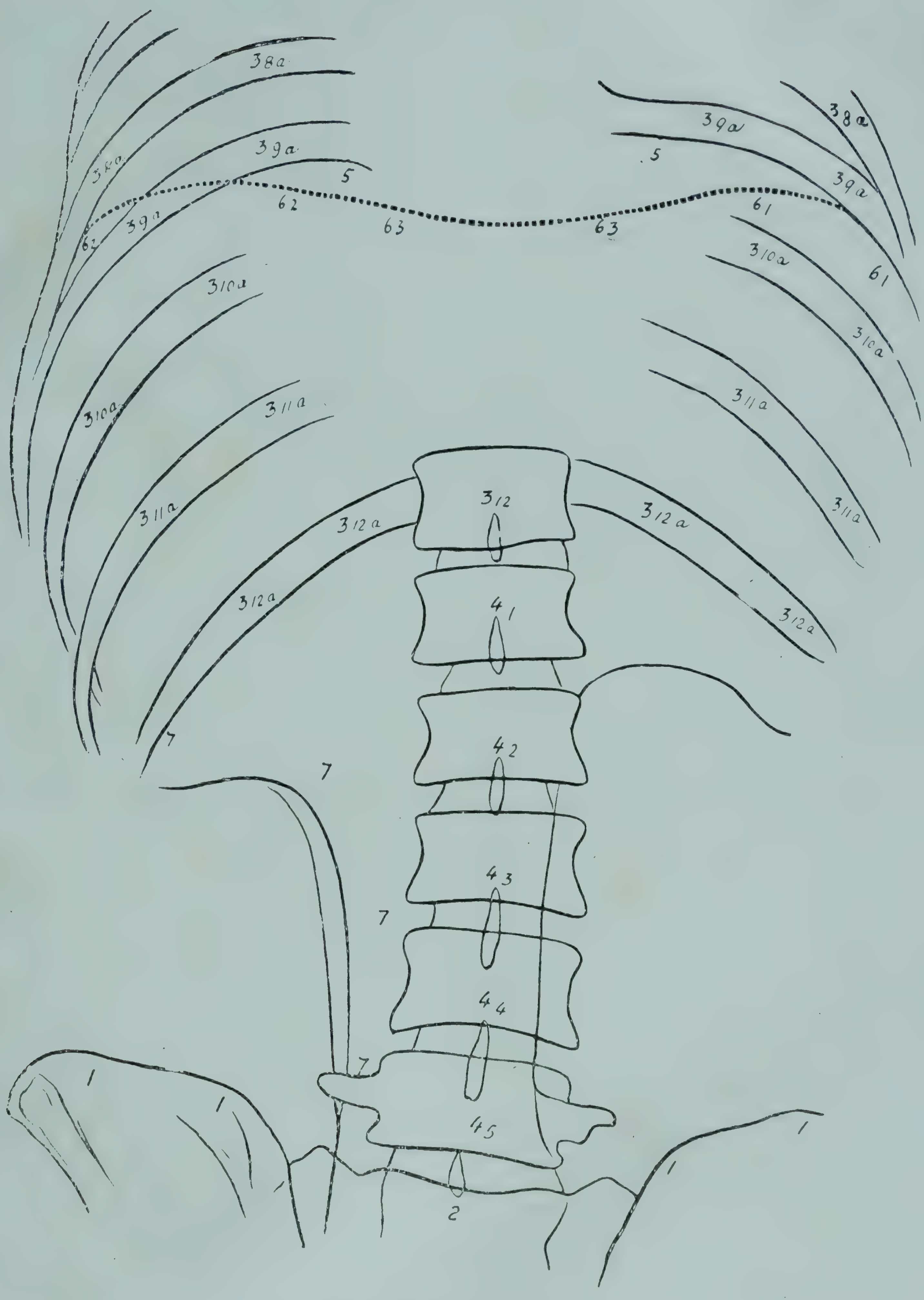
7 The Right Rectus Contracted.

REFERENCES TO RADIOGRAPH VIII

1 The Iliac Bones.
2 The Sacrum.
3_{8a} The Eighth Ribs.
3_{9a} The Ninth Ribs.
3_{10a} The Tenth Ribs.
3_{11a} The Eleventh Ribs.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4_{1} The First Lumbar.
4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.
5 The Heart.
6_{1} The Upper Margin of the Left Dome of the Diaphragm.
6_{2} The Upper Margin of the Right Dome of the Diaphragm.
6_{3} The Central Tendon.
7 The Right Rectus Contracted.

N.B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XXIX



Line Drawing of Radiograph VIII

POINTS OF STUDY :—

N.B.—After reading the last three plates our readers would be able to identify the different parts of the body included in this radiograph. Again there is the help of the references. So we do not note these parts here in detail. The thick shadow on the right of the spine is thrown by the right rectus. If we compare the breadth of this shadow with that of the shadows of the recti in Nauli-Madhyama at the level of upper border of the second lumbar, we find that they are equal. This is because the right rectus in this experiment was considerably relaxed and therefore broadened, while the subject was being skiagraphed.

The circumstance noted in the last paragraph has vitiated the results of this experiment and we would not have described it here, had it not been possible to make out a few points of importance from the radiograph as it stands before us.

1 — The rectus while being relaxed tends to assume its original fan-shape. Hence the right rectus is casting a broader shadow, being comparatively relaxed.

2 —(a) A comparison between the relative positions of the lower ends of the shadows of the last three right ribs as seen in this radiograph and in the radiograph of Uḍḍiyāna, will show that the eleventh rib has become depressed somewhat, but the tenth rib has become much more depressed owing to the contraction of the right rectus.

(b) A similar comparison between this and the radiograph of Nauli-Madhyama will show that the relative position of the ribs under consideration is the same in both.

EXPERIMENT V

OBJECTS OF THE EXPERIMENT :—

One of the objects of this experiment was to study the position of the diaphragm during Vāma Nauli or the left aspect of Nauli, with a view to contrast it with its position during the other two aspects of the same exercise. Another object was to note the position of the ribs during Vāma Nauli, with a view to compare it with their position in Nauli-Madhyama and Dakshiṇa Nauli. The third object was to study the relative positions of the diaphragm and the ribs with a view to compare them with the relative positions assumed by these organs either in the central or in the left aspect of Nauli.

PREPARATION OF THE SUBJECT :—

The same subject as in the last experiment was immediately taken up for this work.

EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the last four experiments. It will be noted, however, that owing to the unequal contraction of the right and left recti of the abdomen, the spine has undergone a considerable side bent. After practising Nauli-Madhyama, the subject relaxed the right rectus, maintaining the left one in vigorous contraction. The radiograph taken in this condition is shown in Fig. XXX. Fig. XXXI gives the line drawing of the same.

Fig. XXX

Radiograph IX



Position of the Diaphragm and the Ribs
during
Vāma Nauli.

References to Radiograph IX

1 The Iliac Bones.

2 The Sacrum.

3_{8a} The Eighth Ribs.

3_{9a} The Ninth Ribs.

3_{10a} The Tenth Ribs.

3_{11a} The Eleventh Ribs.

3_{12} The Twelfth Dorsal.

3_{12a} The Twelfth Ribs.

4_{1} The First Lumbar.

4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.

5 The Heart.

6_{1} The Upper Margin of the Left Dome of the Diaphragm.

6_{2} The Upper Margin of the Right Dome of the Diaphragm.

6_{3} The Central Tendon.

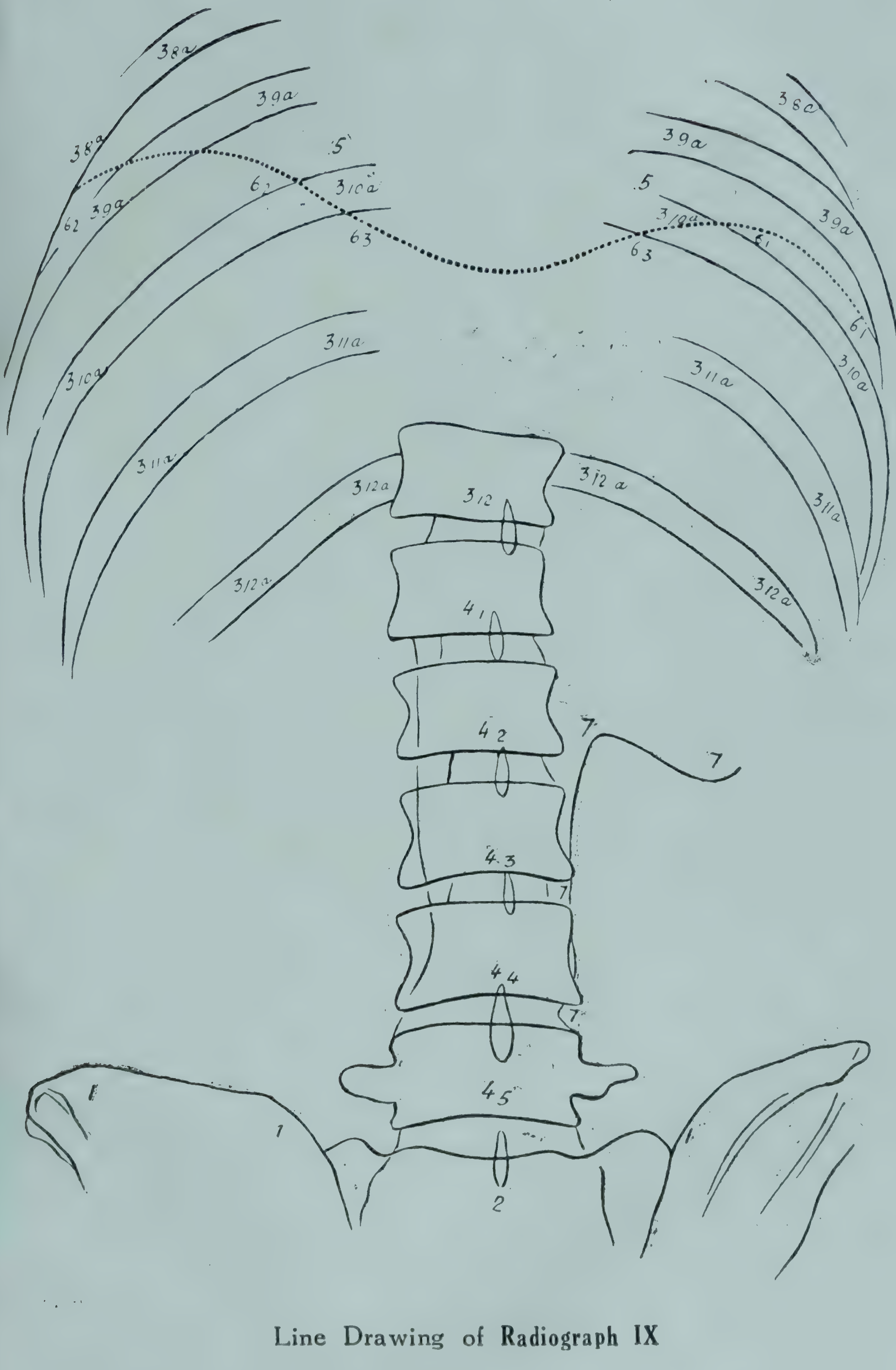
7 The Left Rectus Contracted.

References to Radiograph IX

1 The Iliac Bones.
2 The Sacrum.
3_{8a} The Eighth Ribs.
3_{9a} The Ninth Ribs.
3_{10a} The Tenth Ribs.
3_{11a} The Eleventh Ribs.
3_{12} The Twelfth Dorsal.
3_{12a} The Twelfth Ribs.
4_{1} The First Lumbar.
4_{2}, 4_{3}, 4_{4}, 4_{5} The Successive Lumbar Vertebræ upto the Fifth.
5 The Heart.
6_{1} The Upper Margin of the Left Dome of the Diaphragm.
6_{2} The Upper Margin of the Right Dome of the Diaphragm.
6_{3} The Central Tendon.
7 The Left Rectus Contracted.

N.B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XXX



Line Drawing of Radiograph IX

POINTS OF STUDY :—

1 — A comparison between the relative levels of the two domes of the diaphragm during Vāma Nauli and Nauli-Madhyama on the one hand and Vāma Nauli and Uḍḍiyāna on the other, will show that in Uḍḍiyāna the two domes stood at the same level. In Nauli-Madhyama the left dome was slightly lower than the right. In Vāma Nauli left dome is much lower than the right.

2 — Similarly a comparison between the relative positions of the lower ends of the shadows of the last three left ribs as seen in this radiograph and in the radiograph of Uḍḍiyāna on the one hand, and a similar comparison of the same as seen in this radiograph and radiograph of Nauli-Madhyama on the other hand, will show that the ribs under consideration have become depressed in passing from Uḍḍiyāna to Nauli-Madhyama and that they have experienced greater depression in going from Nauli-Madhyama to Vāma Nauli.

3 — Comparing the shadows of the tenth left rib and the left dome of the diaphragm in Vāma Nauli and Nauli-Madhyama, we clearly see that the left dome stands lower in Vāma Nauli than is Nauli-Madhyama.

4 — Points 3 and 4 put together show that in Vāma Nauli the ribs and the left dome of the diaphragm are depressed simultaneously.

5 — The narrow shadow of the left rectus shows that the muscle has been maintained in vigorous contraction.

6 —(a) The distance between the two upper corners of the first lumbar vertebra is 4.8 cm.

(b) This distance is the same as the distance between these two corners recorded in the first three

experiments. This fact clearly proves that *at least* at the level of these corners, the distances between the tube and the subject, and also between the subject, and the plate, were the same in this experiment as in the first three. Hence a comparison between measurements taken at this level would yield correct results.

(c) The distance between the tenth ribs at the level of the upper border of the first lumbar was 23.2 cm. in forced expiration, 26.2 cm. in Uḍḍiyāna, and 25 . 6 cm. in Nauli-Madhyama. In the present plate it is 25 . 4 cm. that is only a trifle less than that in Nauli-Madhyama. This means that the ribs are extremely depressed in forced expiration, but are much elevated in Uḍḍiyāna. In passing from Uḍḍiyāna to Nauli-Madhyama they are again depressed, this depression being maintained in Vāma Nauli also.

The Semi-Scientific Section

N. B.—The Director of the Kaivalyadhāma entreats every man of means to show his active sympathy for the Ās'rama.

A NOTE ON RESPIRATION

RESPIRATION consists of the alternate expansion and contraction of the thorax, by means of which air is drawn into or expelled from the lungs. In this note we shall first consider the various organs that are directly concerned with this passage of air to and from the lungs; and then we shall see how these organs act in the different stages of respiration.

The organs of respiration may be enumerated as the nose, the pharynx, the larynx, the trachea, the bronchi, and the lungs. Nerves and blood-vessels connected with these parts may also be looked upon as organs of respiration. Generally, however, the nose is not included in such an enumeration. But when we want to write a note on respiration from the Yogic point of view, the nose has not only to be included but to be studied in detail. In dealing with these organs we shall proceed along the passage of the air from outside into the lungs and as we meet with the nose first, we shall start our note with a description of that organ.

THE NOSE—We shall be able to study the nose both externally and internally with the help of a mirror and of the charts given in this article. In using his mirror the reader should allow light to come from his back and fall upon the mirror held in his front. The mirror should be so adjusted as would easily throw reflected light into the nostrils when the head is thrown backward, but would not dazzle the eye.

We always see our nose in the mirror. But what we generally see is only the external part of the nostrils. Let our reader have a peep into the internal portions of the nostrils also. He will find that by the side of the dividing wall, up in the cavity there is a hole in each of the two nostrils. He might think that these holes are a sort of communication between the nose and some other organ situated inside the head. But he would be seriously wrong in

thinking that way. In fact the external nose is only a small part of the organ known as the nose. The most important part of it is situated inside the head, behind the two holes our reader has seen and above the hard palate that forms a part of the roof of his mouth. We shall presently examine this internal part of the nose. But before we do so let us finish with the external part of that organ.

If we feel our nose with our fingers, we find that a very large part of it is mobile. This is because this portion of the nose, including the dividing septum, is made of different cartilages attached to one another by a tough fibrous membrane and covered over by the skin. If our reader again looks into his mirror and examines the inside of his nostrils, he will find that the skin which covers the external surface of the nose, continues inward and also covers the lower chamber of internal nose. He will find even the lower portion of the septum clothed similarly in skin. This portion of the nasal cavity is called the *vestibule.* (See Fig. XXXII) From the walls of this vestibule, our reader will find, a number of stout and stiff hairs projecting. Out of these hairs, those that grow from the front part project backward, whereas those that rise from the back part project forward. Thus a seive-like arrangement is provided just at the entrance of the nose. The external nose has two ends. The upper end which is connected with the forehead is called the *root,* and the lower end which is free is called the *apex* of the nose.

If we again feel the flexible part of our nose and examine the upper and posterior borders of it, we find them hard. This is because the elastic part of the nose is attached to bones at the top and behind. In Fig. XXXIII the mobile nose has been removed and bones to which it is attached are exposed to our view. Our reader will immediately see that the bony borders which carried the flexible attachments of the nose, represent a picture exactly similar to that of the heart drawn in the playing cards. Let us observe a few facts about this bony aperture that directly

Fig. XXXII

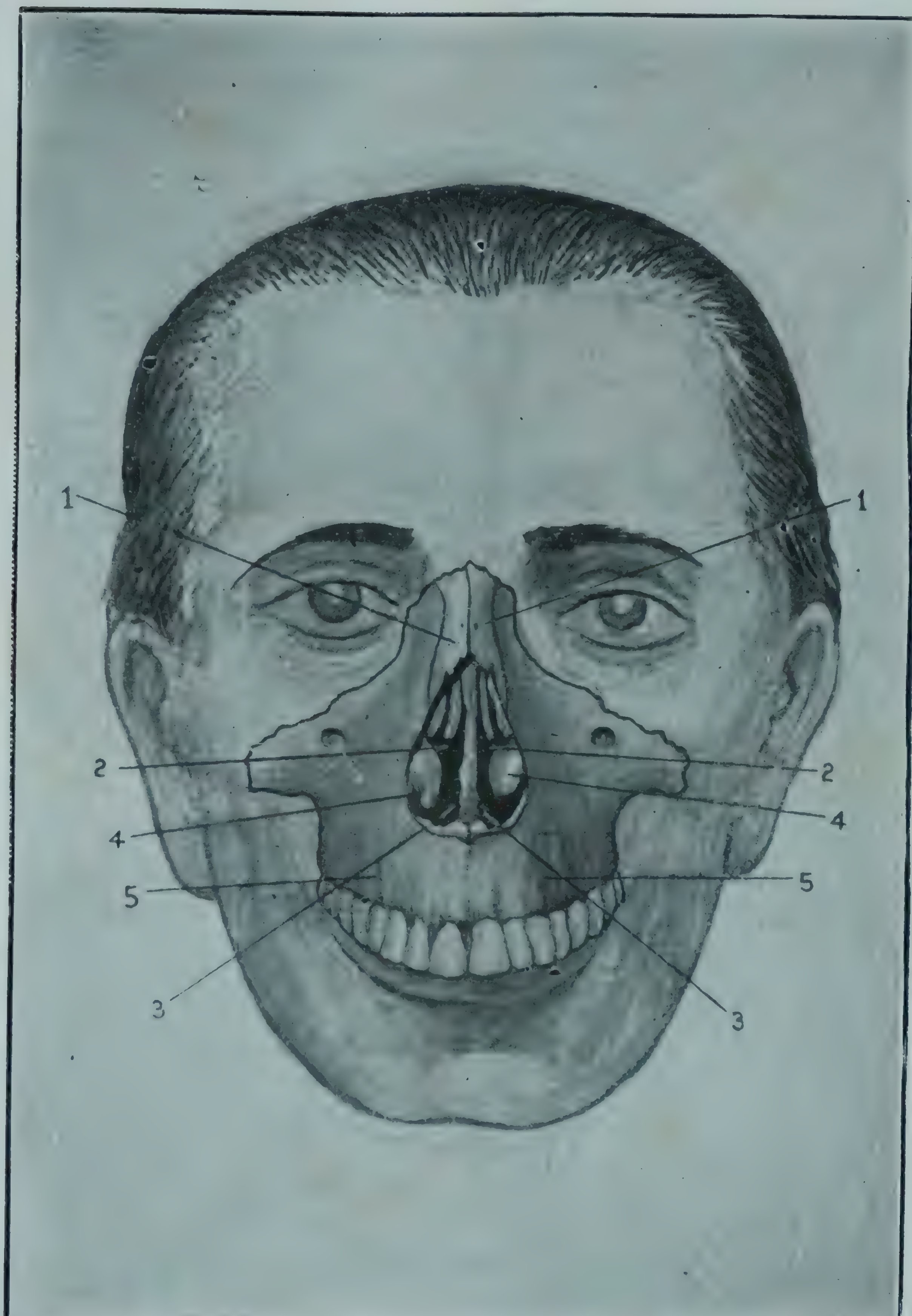
a b



Vertical Section through the Head Indicating the Respiratory Tract etc.

1 Base of the Brain. 2 Tract of the Olfactory Nerves. 3 Bulb of the Olfactory Nerves. 4 Branches of the Olfactory Nerves. 5 The Septum of the Nose. 6 Bony Folds of the Nose. 7 Eustachian Tube. 8 The Hard Palate. 9 The Soft Palate. 10 Mobile Part of the Nose.

Fig. XXXIII



Face with the Mobile Nose Cut off and the Nasal Bones and Cavities, with the Upper Jaw-Bone Exposed.

1 The Nasal Bones. 2 The Nasal Cavities. 3 The Nasal Septum. 4 Scroll-like Bones. 5 Upper Jaw-Bone.

concern us. Below the forehead and between the eyes there are two bones which we can feel externally. They are called the *nasal bones (1)* and form what is known as the bridge of the nose. A vertical line *(3)* is seen dividing the aperture into two exact halves. This represents the nasal septum. The circular curves at the bottom belong to the two upper jaw-bones *(5)*. These curves mark the lower borders of the two holes observed by our reader in the back part of his external nose.

We have already stated that the external nose is only a small part of the real organ. The most important part of it is situated inside the head. We have now removed the mobile nose and come to the entrance of the inner cavities. Let us now note what is there inside the aperture that lies before us in Fig. XXXIII.

The aperture which is divided into two halves by the nasal septum leads to two cavities that are roughly speaking oval-shaped. These cavities continue backward and open into the throat with holes similar to those we observe on the bony surface before us. Each of these cavities has a floor, a roof, and a medial and a lateral wall.

The septum which divides these cavities stands for the medial walls of both. It is made of bones all along except in front where a large cartilage fills up the gap. The floor is also bony. A reference to Fig. XXXIIa will show this floor in a vertical section. It is made of two bones. The front part is made of the upper jaw-bone and the back part, the hard palate. If we feel the roof of our mouth with our finger from the upper teeth backward, we will meet with two hard surfaces. One is rough and the other is smooth. The rough surface which we feel just above our teeth is the upper jaw-bone in which the teeth are set. The hard but smooth surface that we cross when the finger is moved backward belongs to the hard palate bone. Behind this the soft palate can easily be felt. Fig. XXXII shows that the upper surfaces of the two bones are horizontal and that is why the floor of the nasal cavities is horizontal also. So the upper

jaw-bone and the hard palate at once form the roof of the mouth and the floor of the nose. That means the nasal cavities lie just above the roof of the mouth. The lateral walls of the nasal cavities are somewhat complicated. They are also made of bones. They rise from below at some distance from the septum, but as they rise they incline towards the septum to meet it at the roof. Some idea of this inclination of the lateral walls can be had from Fig. XXXIII. Here the bony aperture represents the external borders of these nasal walls. So these cavities are broad below, but narrow down at the top. From the lateral walls arise inside the cavities scroll-like bones. One of them has been marked in Fig. XXXIII *(4)*. These scroll-like bones extend all along the lengthof the lateral walls and open backward into the throat. Now we consider the roof. This is also a bony structure. The floor of the nasal cavities is horizontal; but theroof is arched. An idea of this arch can be had from Fig. XXXIIb, where the septum is shown arching at the top. Now this septum rises direct to meet the roof, and therefore the upper curve of the septum fairly represents the arch of the roof. We may note especially two bones that form the roof. The nasal bones that have already been noticed form the front slope of the arching roof. Behind these nasal bones the roof is formed by a big bone called the *ethmoid*. The ethmoid is at once the roof of the nose and a part of the floor of the brain. That means it separates the nasal cavities from the brain. Thus the nasal cavities stand between the mouth and the brain; and open backwards into the throat just above the soft palate.

(To be continued)

THE RATIONALE OF YOGIC POSES

(Concluded)

WITHOUT entering into any discussion upon his general theory, we shall see whether the ancient Yogic savants had anticipated the other two principles which Mr. Maxick claims to have discovered.

Our readers have read our article on S'avāsana and studied its technique. It requires every muscle in the body to be relaxed. Yoga enjoins the most wilful and complete relaxation of every muscle tissue in this pose. Further, the practice of keeping a particular muscle contracted while others roundabout it are thoroughly relaxed. This too is being done in the Yogic exercise of Nauli. The abdominal recti are kept contracted while the three muscles standing roundabout them in the front wall of the abdomen are completely relaxed.

There are a number of other Yogic exercises requiring perfect contraction of particular muscles. In every one of them the Yogic seers have taken advantage of the two principles laid down above. We do not wish to take our readers into the intricacies of these exercises at this stage.

The two examples given above are, however, sufficient to convince our readers that the ancient savants who invented and formulated the Yogic exercises, had a clear grasp of the principles which the Western physical culturist thinks he is the first man to discover.

Here a pertinent question may be asked. If the Yogic seers had had a clear grasp of the principles underlying muscle culture, how is it that they did not formulate a system such as is developed by Mr. Maxick or some such physical culturist in the West to-day? To this question the following answer may be given.

On the physical side the Yogic savants aimed at physiological perfection as a whole and did not care for the external form of the body. As such they have taken as much care of the muscles as is necessary for the health of an individual. Wherever muscles were found to be of a great physiological advantage, they were cultivated as much as any wise modern physical culturist would do. We shall make our point clear by an example. So far as the physiological functions are concerned the muscles of the thorax and of the abdomen play an important part. The muscles of the upper and the lower extremities are of little consequence. Anybody that has some acquaintance with the breathing exercises and abdominal exercises taught in Yoga, will have to admit that that system has made ample provision for building up the muscles of the thorax and the abdomen. As for the muscles of the extremities the relaxation exercises of S'avāsana and the incidental contractions and stretchings in doing Yogic poses, were considered sufficient to keep the muscles of the lower and upper extremities healthy.

So it will be clear that the Yogic savants cultivated muscles for physiological perfection. They paid more attention to those that were physiologically more important and less attention to those that were of less physiological consequence. They never thought it desirable to develop a system of the Western type.

Because the Western physical culturists *in general,* care for the muscles for their own sake irrespective of their relative physiological importance! To many of our readers who may be looking upon everything coming from the West as scientifically sound, this statement of ours may seem injudicious. But we are making it after a very careful consideration of what the Western physical culturist is doing to-day.

Take for instance Mr. Maxick's system of muscle control. He would pay the gastrocnemius of the calf, as much attention as to the abdominal recti, although there is so vast a

difference between their physiological importance. Nay, more. Even in the case of the recti, he would stop short with their isolation, he would not undertake the rolling manipulations. That is, in the technical language of Yoga, he would practise Nauli-Madhyama, but would not practise the churning. Now the *real* physiological advantage of the contracted recti lies in their rolling manipulations as they give an automatic massage to the abdominal viscera and not to their mere isolated contraction. This shows that Mr. Maxick cares for the recti in their own interest and not in the interest of the viscera lying behind them.

What we have said of Mr. Maxick applies more or less to nearly every one of the physical culturists of the West. In their enthusiasm for muscle building, they have neglected the claims of the other most important systems working in the human body. Of late a reaction has, indeed, started. But there is still little evidence to show that the Western physical culturist is in a mood to assign the legitimate places to the other systems of human bodily mechanism.

Some years ago an interesting experiment was performed in the field of physical culture in the West. Some naval cadets were placed under *special and systematic* physical training for four years. At the end of this period, however, it was found that the addition of lung area gained by exercise did not keep up with the increase thus caused in the muscular substance, and that the vital index always became smaller in those who had gained weight and strength by special physical training.

The experiment requires no commentary. Disproportionate attention to muscle culture can lead to this and to no other result. That is why the ancient Yogic savants did not develop a system of the Western type.

The most wonderful circumstance is that in their enthusiasm for muscle building, the Western physical culturists have not paid due attention even to the real source of muscular power, we mean the *nerves*. The following quotation will show the exact relation between muscular energy and nerve energy.

"Taking firstly the case of nerve action on muscle: it is a nerve impulse coming from cells in the brain and spinal cord that makes muscles contract; and the difference in muscular power between man and man is much more a matter of nerve force than of muscular force. All muscles of the same species of about the same size and same age, the same degree of nutrition and same freshness, have about the same amount of contractile force, but there is a great difference in the contractile force actually exerted. One man's grip may have twice or three times the force of another man's grip; and this is largely a question of the energy liberated in the motor nerve cells. This is the variable factor, the explosive value of the nerve cell. No doubt such value varies not only in motor cells, but also in sensory cells, and no doubt the energy liberated from the motor nerve depends greatly in many cases on the energy liberated by the sensory cell that excites it. Thus, a slate-pencil squeaking on a slate has very different explosive value in the case of different men. One man may take no notice; another man may say, 'Do stop that noise'; and yet another may be moved to strong language. Again, one man may jump out of his seat at a sudden flash of lightning, and another man may be unmoved.

"Further, there are great differences in the total energy that cells contain. One man's motor cells may have enough energy to walk from London to Brighton; another man's motor cells may be exhausted before he has got half way. It is not a question of muscular energy; it is a question of nerve energy."

This quotation will make it amply clear that in cultivating muscles man has to pay supreme attention to nerves.

It has already been stated that a reaction in favour of the nervous, glandular and respiratory systems has already set in. We only wish that the reaction thus started, is carried to its scientifically legitimate conclusions and the modern civilization is freed from the tyranny of muscles!

This much for the muscular system.

Upto now we have examined the Yogic system of physical culture in the light of the principles which should characterize an ideal system of body building and have found it to be in every way satisfactory. It has, perhaps, the best claim for being called a system of physical culture in the modern sense of the word. It not only aims at the physiological perfection of the human body as a whole, but it also pays adequately proportionate attention to the different systems working in the human organism. It is capable of increasing the vital index instead of lowering it and requires only the minimum expenditure of energy for undergoing the exercises. For a man engaged in the non-violent pursuits of life, there can be no other system more suitable than the Yogic system of physical culture. He will not only be blessed with health and longevity, but will also find his brain working with the greatest efficiency.

This is true of the Yogic system of physical culture taken as a whole. The poses form an important part of the scheme and as such are capable of giving nearly all the physiological advantages arising from the whole, though on a smaller scale. The only system that is not helped by the poses is the respiratory system.

The comparisons incidentally introduced between the Yogic system and the systems of the West, should not give the impression, that we do not appreciate the efforts of the Western physical culturists in the field of physical culture. We have a high regard not only for their industry and organization, but also for the way in which they are bringing their scientific knowledge to bear upon their art. What we want to suggest is that their systems are suffering from some serious disadvantages from which the Yogic system is entirely free and that the Yogic system can stand comparison with them very favourably!

NOTE—This article has been written from a strictly physiological point of view. Man is not, however, only a physiological being, but is also a social being. As such he belongs to a nation and has a duty to his motherland. He

has to defend his nation at all costs. If he could have done it without violence, the Yogic system of physical culture would have been ideal for him. But in the present age as the atmosphere is surcharged with militarism, violence looks obligatory and the Yogic system cannot become a national system of physical culture. Violence needs muscle culture even at the cost of physiological advantages !

We are of opinion that muscle necessary for any amount of violence can be cultivated without losing any physiological advantages, if a system combining the best features of Yogic and non-Yogic systems of Indian physical culture, is evolved into a systematic whole. The task is extremely difficult. But a man conversant with both these types of body building and endowed with scientific accuracy and physiological insight, can accomplish it, provided he gets the necessary support in men and money. Will such a man come forward and will he be equipped with the necessary means ?

Again, the problem of physical culture as it is discussed in this article is treated from the point of view of an individual. It is true that the exercises examined here scientifically, admit of being done simultaneously by a number of people, and can safely be introduced in schools and colleges. But we have to make it clear to our readers that the problem of physical education in schools and colleges, is in several respects different from the one that can be solved by means of the Yogic system of physical culture. Because in the physical education of school boys, we have not only to provide for muscle building, sports and games, but also for a co-ordination of mental and physical education, etc. Hence there should be no attempt to confine physical education in schools to a practice of Yogic exercises only. Needless to say that every school will be immensely benefitted if it includes Yogic exercises in its programme of physical education.

The Popular Section

N. B.—Instruction in Yogic culture higher as well as lower will be given gratis at the Ās'rama to everyone that earnestly seeks it.

Fig. XXXIV



Sinhāsana or The Lion Pose.

(Back View)

SINṄHĀSANA

or

THE LION POSE

THE NAME :—

This pose is called Siṅhāsana because in it the student imitates the lion with his jaws thrown wide apart and his tongue fully stretched out. In Saṅskṛita Siṅha means a lion.

THE TECHNIQUE :—

To start with the student fully stretches out his legs on his seat. Then he bends one of his legs, say the right, in the knee, and folds it on the thigh, just as in the case of Siddhāsana. But there is some difference in the ultimate position of the foot in this pose and in Siddhāsana. (See Figs. XCVIII and XCIX, Vol. II) Whereas in Siddhāsana the heel is set against the perineum, here the heel is set below the opposite, that is, the left buttock, so as to have the right ankle by the left side of the perineum. In this position the upturned sole will show itself partially from behind and the toes will spread a little beyond the thigh. The sole and the toes as described here, can be seen in Fig. XXXIV which illustrates the back view of the Lion Pose. When the student feels secure on his right heel, he bends his left leg, and crossing the right leg from below, sets the foot under the right buttock, so as to have the left ankle by the right side of the perineum and the toes spread out beyond the right thigh. When this is done the student finds himself sitting practically on the heels. In order to secure the necessary ease and comfort which must characterize every Yogic pose, the student hereafter puts his whole weight on the thighs

and especially on the knees which are made to rest on the ground. This gives a forward inclination to the whole trunk, the buttocks being lifted up from behind.

The muscles of the arms and forearms are stiffened, the elbow-joint is fully extended and the palms are made to cover their corresponding knees, the fingers being spread out to imitate the broad paws of the lion.

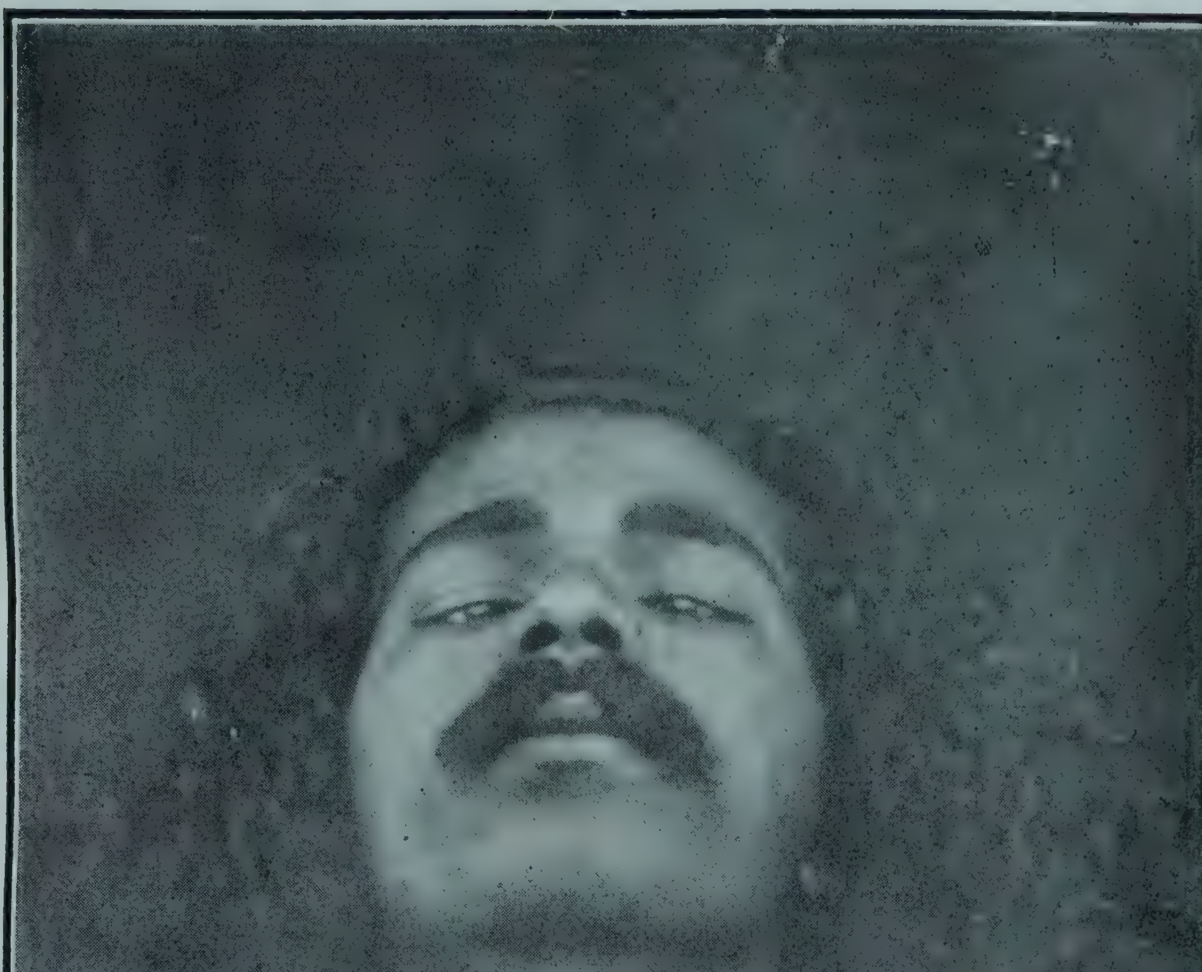
The trunk along with the spine is held erect, the chest is thrown out, and the braced up shoulders are made to exert a gentle pressure on the knees through the upper extremeties.

Then begins the execution of the most important part of Sinhāsana. The jaws are thrown wide open and the tongue is stretched out to its atmost limit. The eyes are fixed either between the eyebrows as in the Frontal Gaze, or on the tip of the nose as in the Nasal Gaze. The opposite picture is with the Frontal Gaze. The Nasal Gaze has been illustrated in Fig. XXXV. Generally, though not necessarily, the chin is pressed against the chest so as to adjust it in the jugular notch in order to form Jālandhara-Bandha. Fig. XXXVI shows this pose with the Chin-Lock.

Instead of the right leg being taken up first and the left made to cross it from below, the left leg may be taken first and the right may be passed underneath it.

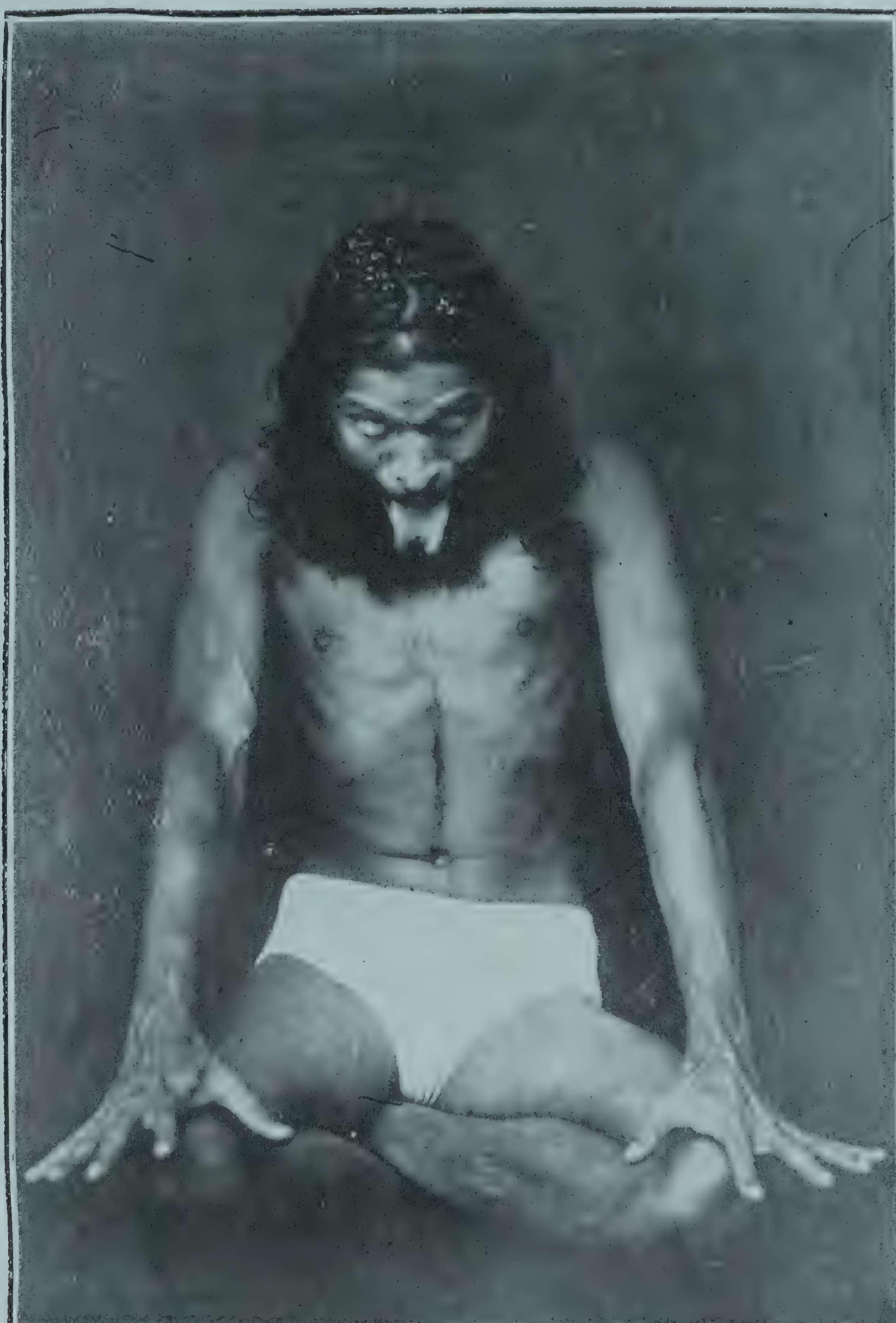
During the pose breathing becomes mainly oral, most of the air from the lungs being expelled through the mouth in exhalation, and most of the air being drawn into the lungs the same way in inhalation. The nasal passage is very sparingly used for the incoming and outgoing breath.

Fig. XXXV



Nāsāgra—Drishṭi or The Nasal Gaze.

Fig. XXXVI



Sinhāsana or The Lion Pose.

(Front View)

The pose by itself has not got much physical or therapeutical value, much less spiritual; so it need not be maintained for any considerable time. Its great physical and therapeutical importance when practised along with the Tongue-Lock in rapid succession, has been mentioned on p. 56 of the last issue.

Again even when the Āsana by itself is not of much consequence either physically or spiritually, it is a very valuable exercise as a preparation for the three Bandhas, Uḍḍiyāna, Mūla and Jālandhara. The mere widely throwing open of the jaws and the drawing out of the tongue make the muscles of the neck elastic, thus facilitating the formation of the Chin-Lock. The attempt at Jālandhara-Bandha, the pressure on the knees exerted through the hands, the erection of the spine and the throwing out of the chest, all put together, give a sort of control over the abdominal recti, thus preparing the student for Uḍḍiyāna. Again lifting up the buttocks with a view to hold the spine erect and sit lightly on the heels, tends to the contraction of such pelvic muscles as facilitate the practice of Mūla-Bandha. Thus it will be seen that the Lion Pose is a fine exercise preparatory to the three Bandhas.

POINTS OF STUDY :—

(a) *Blood-vessels :—*

The external and internal carotids which carry the blood to the head are pressed considerably on account of the Chin-Lock and their flow is partially checked. (Compare blood-vessels in Sarvāṅgāsana, Vol. I and also in Viparīta Karaṇī in the last number) This partially checked blood current is diverted to the different organs situated in the neck.

When no Chin-Lock is formed but the oral exercise included in this pose is made to alternate

with Jihvā-Bandha, all the blood-vessels supplying the neck and the mouth are affected, promoting blood circulation therein.

(b) *Muscles :—*

The muscles brought into play in this pose, especially when it and the Tongue-Lock are made to run in rapid succession, are those of the face, the neck, the pharynx, the tongue and also those connected with the tongue.

(c) *Vertebræ :—*

The cervical vertebræ are fully stretched in the forward bent of the neck. The vertebræ in the remaining part of the spinal column also receive a steady upward pull.

(d) *Nerves :—*

The cervical ganglia of the sympathetic are especially affected in this practice, the spinal nerves issuing from the cervical part of the spine being also considerably influenced.

NOTE—

Yogic physical culturists will do well to take this exercise in the end of their daily programme. Maximum time to be devoted to it should not exceed three minutes.

Fig. XXXVII



Preparation for Vajrāsana.

VAJRĀSANA

or

THE PELVIC POSE

THE NAME :—

This pose is called Vajrāsana because it affects the pelvis. This statement will be made clearer when the supine variety of this Āsana is studied in the next article. Vajra in Yogic literature does not mean the pelvis, but it means the penis. So it will be seen that the name Pelvic Pose is only a free rendering of the original name Vajrāsana. It is to be, however, noted that this pose does affect the whole of the pelvis as much as the penis itself.

THE TECHNIQUE :—

As in the case of the previous practice, the student fully stretches out his legs on his seat to start with. Then he bends one of his legs, say the left, in the knee and folds it on the thigh. But he does not keep the knee resting on the ground as in the last Āsana, but raises it to its full height while bending it for further action. Now the foot is resting on the ground in front of the left buttock, and the knee stands high up against the left half of the chest. (Vide Fig. XXXVII) After this the student raises his left buttock reclining his trunk slightly to the right which is made to rest on the right hand placed by the side of the right thigh. Then with his left hand he catches hold of his left foot, as shown in Fig. XXXVII, and drawing it to the left of the left thigh, gets it fully extended so as to upturn the sole. While doing this the knee is lowered to the ground, the toes are arranged behind the slightly raised left

buttock, pointing to the right, and the heel is made to lie to the left, clear of the body. Thus the foot and the leg form a sort of a circular curve which is made to surround the left buttock. (See Fig. XXXVIII) The right thigh, leg and foot are carried through a similar procedure and are arranged on the right side, the foot again going round the buttock. In this final arrangement of the feet, each heel will be kept by the side of the corresponding hip-joint, the upper surfaces of the feet will touch the seat, the soles will be upturned, and the two sets of the toes will be pointing to each other with some space left between them.

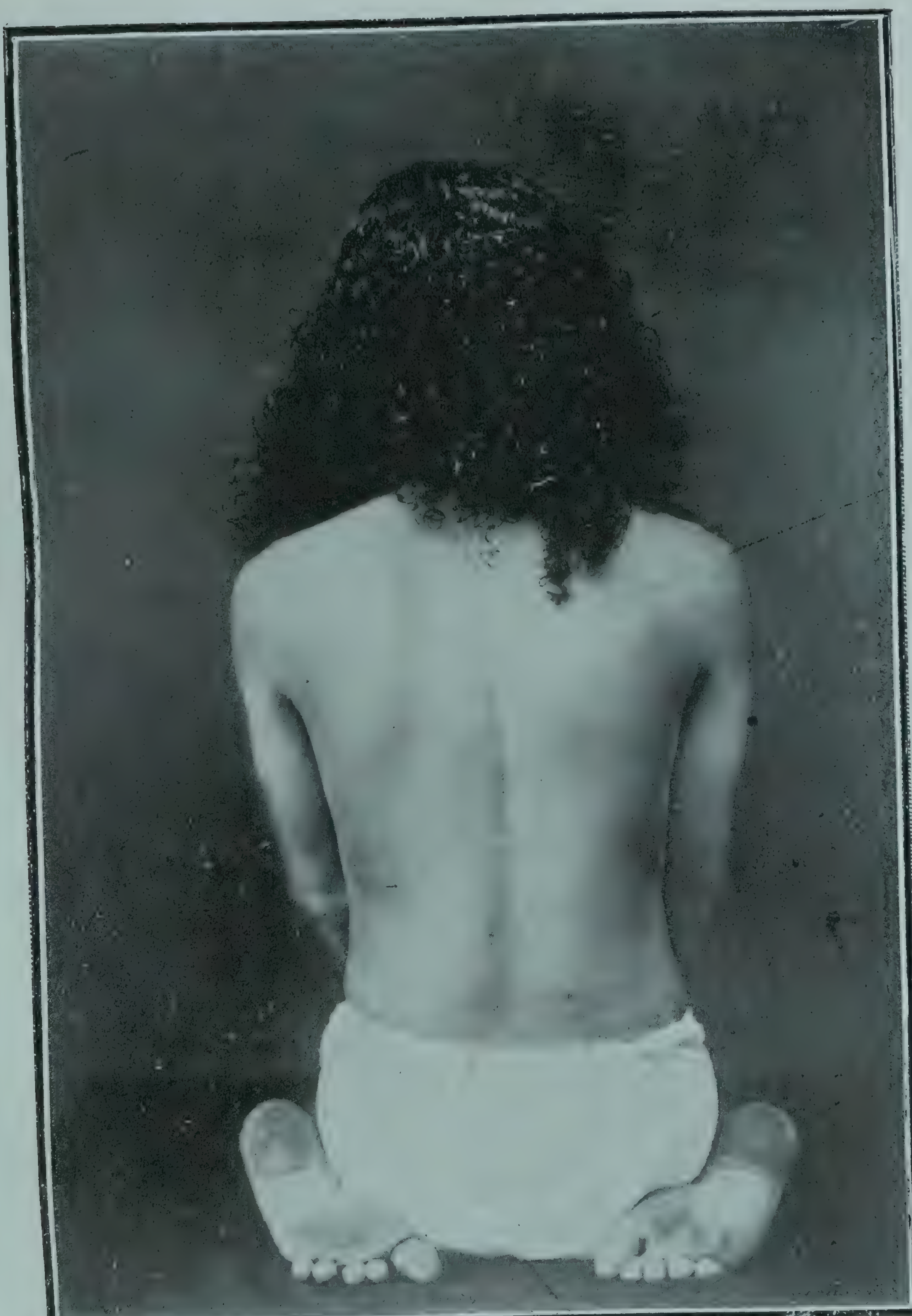
There is another way of arranging the legs and the feet in this pose. Instead of keeping them clear of the thighs and the buttocks, they are placed underneath the latter, so that the student sits on his ankles. Naturally the two sets of toes are not now held apart, but they cross one another behind the coccyx. (See Fig. XXXIX)

With the lower extremities thus arranged and with the knees made to lie close together almost touching each other, the student sits erect on his buttocks, holding the spine straight. With the palms covering the knees and the eyes closed in concentration, the technique of the pose is completed. (See Fig. XL)

Those people whose joints are stiff and do not admit of easy movements, should practise this pose with caution. No strain should be allowed. First the joints should be accustomed to be more and more flexed. And when they admit of the necessary bent, the full pose should be attempted.

This Āsana is generally practised for spiritual purposes. When so used its time limit would depend upon the duration of the spiritual exercise.

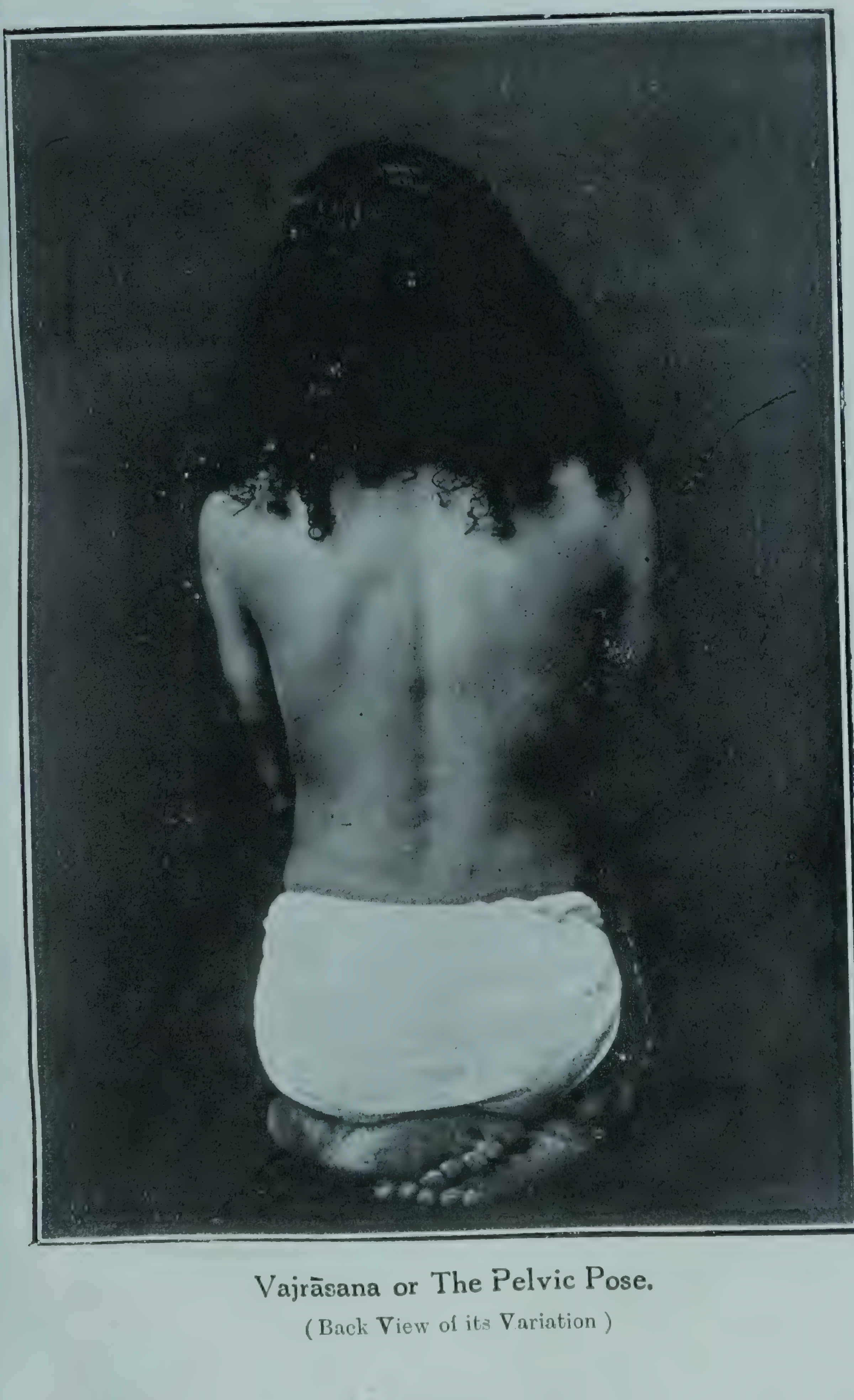
Fig. XXXVIII



Vajrāsana or The Pelvic Pose.

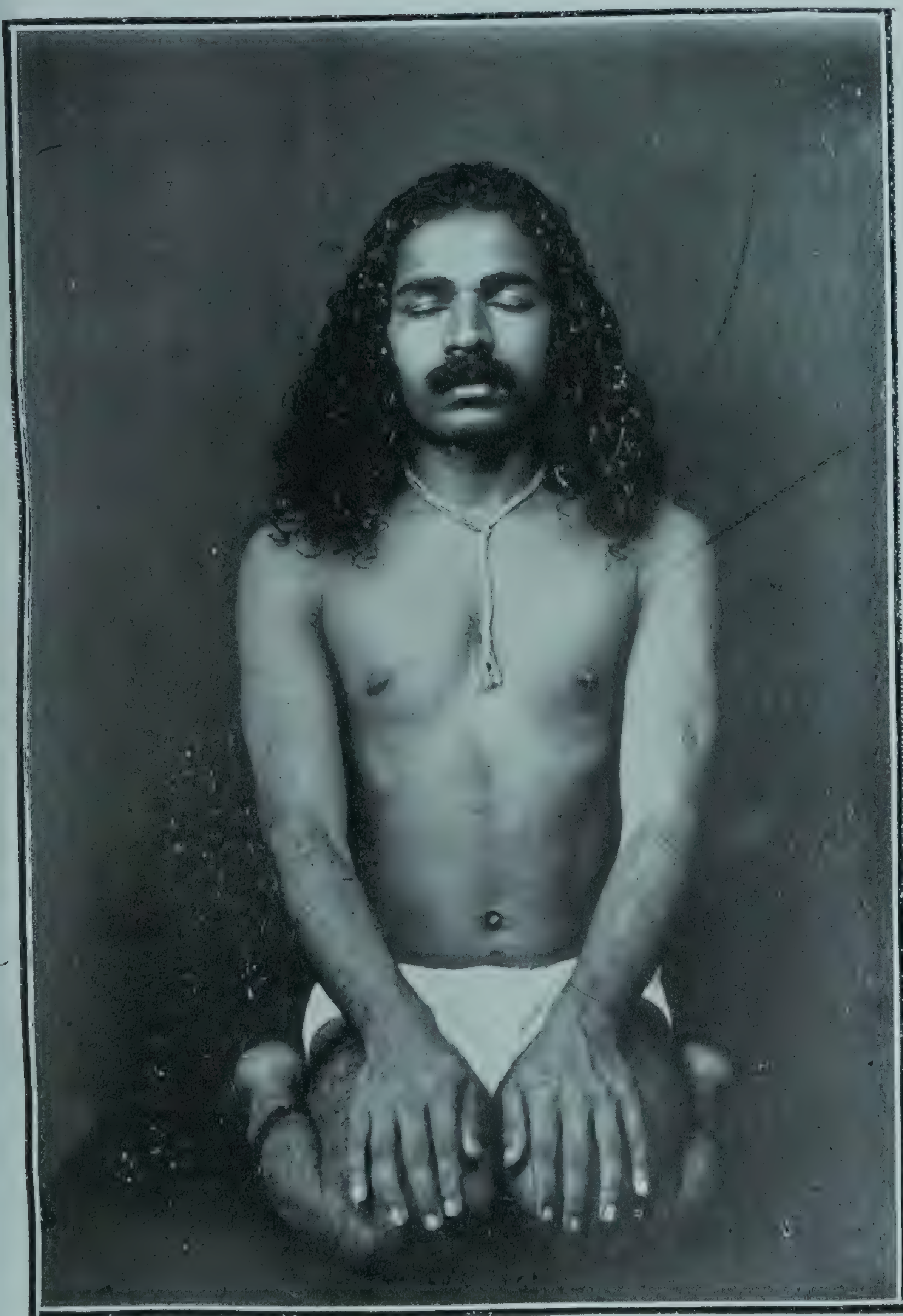
(Back View)

Fig. XXXIX



Vajrāsana or The Pelvic Pose.
(Back View of its Variation)

Fig. XL



Vajrāsana or The Pelvic Pose.

(Front View)

POINTS OF STUDY :—

(a) *Muscles :—*

Throughout the lower extremities, the flexors are greatly contracted and the extensors are highly stretched.

(b) *Blood-vessels :—*

The condition of the muscles referred to in the preceding paragraph considerably checks the blood circulation in the lower extremities. This being the case, the pelvic region gets a larger blood supply from the abdominal aorta.

(c) *Nerves :—*

The larger blood supply mentioned above tones up the coccygeal and secral nerves.

NOTE—

The name Vajrāsana is often used for Siddhāsana or the Accomplished Pose. When we remember the meaning of the word Vajra in Yogic literature and also take into consideration that in Siddhāsana one of the heels is set at the root of the penis, we can at once understand why the Accomplished Pose is also called Vajrāsana. The significance of the name in the case of the present Āsana has already been explained.

SUPTA-VAJRĀSANA

or

THE SUPINE PELVIC POSE

THE NAME :—

This pose is called Supta-Vajrāsana because the student lies supine in this Āsana instead of sitting erect as in the original Vajrāsana. In Sanskṛita Supta means asleep. Fig. XLI illustrates the full pose.

THE TECHNIQUE :—

As this practice is only a further development of Vajrāsana, the student arranges his lower extremities as detailed in the last article. It is needless to say that both the varieties of the Vajrāsana arrangement are available for this development. After this the student tries to lie on his back. This is done step by step. First he reclines backward resting the burden of his trunk upon his hands which are made to serve as props from behind. Then one of the hands is relieved and the burden of the body on that side is thrown upon the elbow which is now made to rest on the seat. The same is done in the case of the other hand. Afterwards even these elbow props are removed and the trunk is made to rest on the shoulder-blades, that is, the large flat bones of the upper back. In the beginning, in this position, the student finds that his spine makes a curve and does not lie straight in contact with the seat. This curve is gradually but considerably effaced and the vertebral column is made to lie along the ground as far as possible. Then comes the the turn of the upper extremities to be adjusted. For

Fig. XLI



Supta-Vajrāsana or The Supine Pelvic Pose.

this work the student slightly lifts up his head, because he has to get his arms and forearms to serve as cushions underneath it. One of the hands is then passed below the head and made to grasp the shoulder-joint on the opposite side. The other hand does a similar thing, the two elbows projecting a little beyond the head on the seat. The eyes may be closed to render significant the word Supta occurring in the name of the Āsana.

As Supta-Vajrāsana is a further development of Vajrāsana, practice of the former should not be started without completely mastering the latter. Special care is to be taken of the ankle-joints which are far more strained in this development than in the original pose.[1] The maximum time to be devoted to this pose should not exceed three minutes for ordinary purposes.

POINTS OF STUDY :—

(a) The action of this pose on the muscles, blood-vessels and nerves is the same as in Vajrāsana. Only it is more accentuated.

(b) In addition to actions noted in (a), the abdominal recti are fully stretched and the bowels and other abdominal viscera are considerably stimulated, the effects on the pelvic organs being greatly pronounced.

1 In getting out of the pose, the student first lets go his hands, then raises his trunk and finally relieves his legs. Any attempt to take off the legs first is likely to injure the ankle-joint.

BRAHMACHARYA

Does It Give Longevity to Yogins?

Brahmacharya is one of the disciplines through which every student of Yoga must go before he can make any progress therein. It is stated by Patan'jali as a Yama (control). He, however, gives no definition of the word. Brahmacharya has to be taken, therefore, in the sense which Yogic tradition ascribes to it, that is, sexual abstinence. The question that naturally arises is whether Patan'jali prescribes celibacy (total sexual abstinence) or chastity (abstinence from unlawful sexual intercourse)? Later Yogic tradition stands for celibacy. Reading between the two *Pātan'jala Yoga Sūtras* bearing on Brahmacharya, however, there seems to be little doubt that Patan'jali allows even chastity to be sufficient for Yogic development. These are the two Sūtras:—

अहिंसासत्यास्तेयब्रह्मचर्यापरिग्रहा यमाः । P.Y.S. II 30.[1]

एते जातिदेशकालसमयानवच्छिन्नाः सार्वभौमा महाव्रतम् । P.Y.S. II 31.[2]

The 30th Sūtra simply lays down the five controls. The 31st prescribes the same, but in a stricter form as it requires them to be practised at all times and under all climes. Patan'jali expressly calls this a stricter form, Mahāvratam, suggesting thereby that the previous Sūtra requires their practice only in a milder form. The stricter form of Brahmacharya is clearly celibacy as is seen from the conditions of the 31st Sūtra. But what is the milder form of Brahmacharya that the previous Sūtra allows? It can be nothing else than chastity, as illegitimate intercourse, which is the only alternative, has absolutely no place in real Yoga.

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1 Inoffensiveness, truthfulness, non-stealing, continence, and non-receiving, are the Yamas.

2 These, when universal, that is, unbroken by time, place, purpose and caste-rules, are great vows.

So it is clear that Patan'jali allows a married life to a Yogin provided the *marital* bond is faithfully kept up, and provided within that bond strict moderation is observed according to the scriptural injunctions. But it seems that he looks upon such Brahmacharya as the minimum, because he also mentions celibacy (total sexual abstinence) and calls it the maximum. So when the question, whether Brahmacharya in Yogins leads to longevity is to be scientifically examined, both chastity and celibacy will have to be taken into account.

The physiological aspect of chastity and celibacy in relation to longevity bears on the sexual glands.[1] Modern scientific opinion is unanimous in declaring that healthy sexual glands ensure long life. Their arguments are as follows:—

Historical records show that persons who kept up their youthful appearance till very late in life, or who reached an extraordinary old age, possessed very healthy and active sexual glands. So also people who have fire and courage in their eyes, people who defy dangers and rule circumstances, people who can mould their own destiny and that of others, are in possession of healthy sexual glands. Castrated people, whether male or female, soon after their sexual glands are extirpated begin to show all the signs of old age. Their bloom disappears, their faces begin to look wrinkled and haggard, their cheeks become pendant and all other symptoms of premature senility present themselves vividly in them. The same is the case with lower animals. But if these glands were again introduced under their skin they soon begin to revive their youthful appearance. People with degenerated sexual glands of both the sexes also exhibit symptoms of old age ; but a treatment with the extracts of these glands lends them again their younger looks.

This relation between youth and sexual glands is explained by the vitalizing effects of the internal secretions of

1 Readers are recommended to study our 'Note on the Reproductive Organs of Man' given in Vol. I, No. 4, for fully understanding the problem discussed here.

these glands upon the organic tissues in general. According to Brown Sequard, these stimulate and sustain the energy of the nerve centre and the cord also. Whether these secretions really belong to these glands or whether they are the products of adrenal rests as Dr. Sajous[1] would have it, there is no difference of opinion on the point that they are produced *in* these glands and have these effects on the organism, as a whole.

Such being the relation between longevity and sexual glands, it only remains to be seen whether chastity and celibacy are capable of keeping these glands active and healthy; and if it is proved scientifically that they are, it would follow that Brahmacharya must be enabling the Yogins to live a long life.

The case of chastity is simple. Married life is, according to the modern sciences, the best way of keeping the sexual glands healthy. When the same is led with chastity and moderation, it is more effective. The agencies most deleterious to the sexual glands are the venereal diseases and excesses. A life of chastity and moderation precludes the possibility of both, and ensures longevity.

But unluckily celibacy stands on a different level. Modern science looks upon it with disfavour and the case of Patan'jali appears to be hopelessly lost. Medical men on the strength of experiments, and clinical as well as anatomo-pathological observations, assert that total abstinence from sexual intercourse leads to premature old age and consequently to premature death. They thus argue out their case :—

(*a*) Like other ductless glands, the sexual glands have an internal secretion which if produced in too large quantities may have toxic effects on the system.

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1 There is no true internal secretion of the *testes*, the products of the epithelial and seminal cells which ultimately take part in the formation of the seminal fluid, being derived mainly from adrenal rests in these cells. " P. 478, Vol. I, *Internal Secretions & Principles of Medicine* by Dr. Sajous.

" There is no true internal secretion of the ovaries, the products of the Grafian follicles and their corpora lutea and of the inerstitial stroma-cells being derived mainly from adrenal rests in these cells. " P. 482. Ibid.

(*b*) The accumulation of this secretion may prove injurious to the condition of the glands themselves.

(*c*) Their complete disuse may lead to the atrophy of these glands.

(*d*) Celibacy may have very injurious effects on the nervous system; it assists in the development of hysteria and neurasthenia.

The following evidence is put forward in support of these propositions.

PROPOSITION (*a*). This proposition is based on the experiments of Loisel who found that the extracts from the sexual glands, if injected into other animals, have toxic effects.

PROPOSITION (*b*). Regaud and Mingazzini are responsible for this proposition. The former tried experiments on the guinea-pigs and the latter on female animals. Both of them found serious modifications in the sexual glands of these animals after enforced abstinence.

PROPOSITION (*c*). Not only the general biological law but clinical observations also support this proposition. Kisch and Lorand have observed several cases where celibacy has resulted in impotence and early disappearance of menstruation.

PROPOSITION (*d*). The high percentage of nervous diseases in the case of old bachelors and spinsters clearly shows, according to various authorities, that their celibacy is responsible for these ailments.

The only conclusion, that is reached in the light of this knowledge, is that celibacy poisons the system, deteriorates the sexual glands so much so that it may lead to impotency, develops nervous symptoms and thus brings on premature senility, and shortens life. Hence it follows that the Yogins, if at all they live a long life, must be doing so only on the strength of other practices. The only result of

celibacy would be to counterbalance the effect of other vitalizing practices and to cause premature old age and death.

Experimental evidence of modern sciences is generally so conclusive that it can hardly be challenged. And yet we humbly suggest that Patan'jali was perfectly right in prescribing celibacy to Yogins with a view to give them the best chances for health and longevity.

We shall examine the evidence of the Western scientists step by step.

The first two arguments brought forth against celibacy point to the dangers of the *accumulation* of the internal secretions. According to the advocates of these arguments, the only healthy way to avoid this accumulation is coitus. Really speaking the semen—ordinary testicular secretion—discharged in a coitus does not directly contain the internal secretion. The accumulation of semen, however, indicates the accumulation of the internal secretion also.[1] But if it could be shown scientifically that there are in Yoga healthier methods of avoiding this accumulation, the point against celibacy is lost. And if it could be further proved that these methods avoid accumulation in a way calculated to help longevity, it would logically follow that celibacy prolongs life.

Some of these healthier methods consist of the Yogic exercises which have already been described in the pages of this journal. They are Uḍḍiyāna, Nauli, As'vini, Mūla-Bandha and Sarvāṅgāsana.[2] We shall now proceed to see how these exercises help celibacy and prolong life.

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1 The latest researches in endocrinology tend to go against this proposition and seem to establish want of interdependence between the internal and the external secretions of the testes. As, however, the arguments levelled againt celibacy are based upon an interdependence between the two secretions, we have tried to meet those arguments on the same hypothesis.

2 For the preservation of celibacy and prolongation of life there are other practices in Yoga far more powerful than those referred to here. We do not mention them here simply because we have not yet treated them in this journal.

It is to be noted that, even in the case of ordinary persons, a part of the secretions of the sexual glands is taken up by the circulation through the lymphatic vessels and is used in building up the tissues at large. But the absorbing activity of the lymphatic vessels and the secreting activity of the sexual glands is disproportionate, the latter secrete much more than the former can absorb; and this leads to the accumulation of secretions. However if the lymphatic vessels can be made to work better and keep pace with the sexual glands there will be no danger of accumulation.

We have ample clinical evidence to show that this absorbing activity of the lymphatics can be increased in the case of genitals. A number of youngsters suffering from nightly emissions have found considerable relief with improved metabolism through these practices. The discharges decreased because of the greater absorption of the testicular secretions, and metabolism improved on account of the effect of the absorbed secretions on the tissues in general. It is to be frankly admitted that the relief is not to be solely attributed to the increased action of the lymphatics, because other physiological effects of these exercises, and especially the reduction of extreme blood pressure in these parts with its evil consequences, are also *partly* responsible for it. But the case that will be presently quoted will leave little doubt as regards the capability of these Yogic exercises to powerfully strengthen the absorbent system of the genitals.

A young man of 20 developed hydrocele early in 1919. Competent medical advice suggested a surgical operation or at least a tapping as the only remedy. The gentleman could not act up to the advice and the disease grew worse. After some three years' suffering, he happily started Yogic exercises referred to above and after some time found that his disease was disappearing. Today the gentleman is almost normal so far as his genitals are concerned. The explanation of the case is this. The lymphatic vessels of the scrotum becoming more active absorbed the fluid accumulated there, and further undue secretion was stopped

by the other tissues being made more healthy. What happened in the case of the scrotum would also happen all over the genitals, because these exercises directly govern the nervous and muscular mechanism of these parts. Thus it would be clear that these exercises do promote activity of the lymphatics and can be made to absorb the testicular secretions, so as to avoid their undue accumulation and to help metabolism through the absorbed secretions.

But the matter does not end here. Even without these Yogic practices, celibacy would not produce toxic effects nor would it deteriorate the sexual glands, if the celibate does not allow his nervous system tobe wrecked by his brutal impulses. The toxic effects referred to in the objection (*a*) are due to the impaired activity of poison-eliminating organs which are very badly affected by strong venereal desires left unsatisfied. The ravages of such desires on the sexual glands themselves are too wellknown. But the question is whether these sexual impulses can be avoided in celibacy. The answer is in the negative, if celibacy is enforced upon a person who is no better than a brute; for in that case, he must suffer as the brutes suffered when Loisel, Regaud and Mingazzini subjected them to experimentation. But the answer is in the affirmative, if celibacy is voluntarily undertaken for a high religious or ethical ideal. It is the unsatisfied sexual hankering and not the accumulated secretion that is responsible for the havoc worked in celibacy. The example of old bachelors and spinsters presenting haggard looks as shown in objection (*d*) has this one lesson to teach. For we know, in this part of the country, a number of religiously minded widows who had little sexual experience and who yet lived a very healthy long life. The truth is that mother Nature is so kind that she adjusts every function in the body; and the secreting activity and the absorbing activity are made to keep pace. The damage done by the suppression of the instinctive sexual desires is more than compensated by the advantages that accrue through absorption of the internal secretion.

Now only one objection remains, that is, objection (*c*) which declares that complete disuse may lead to atrophy of these glands. In the case of persons upon whom celibacy is forced by circumstances, who by morbid habits take pleasure in taking excitants and in keeping genitals perpetually under high tension, who are terribly preyed upon by consequent worries, and who have wrecked their nerves by alarming exhaustion, this is perfectly true. The experimental and clinical evidence that is adduced to support the objection (*c*) is entirely of this character and does not bear on voluntary celibacy practised as a religious or moral ideal. We know at least two cases of highly religious widows who had lost their husbands soon after their marriage, who had no issue and yet in whose case menstruation continued till late in life. So also we know two bachelors who died after they had crossed the century mark. This we think to be natural. The best hygiene of their mind avoided damage to their sexual glands and their secretion being absorbed in the body these glands kept up their activity. The truth appears to be that whenever the secretions are hygienically utilized, the glands continue their function. Whether the secretions are discharged in a coitus or they are absorbed by the lymphatics is immaterial. The Yogins have a special advantage as they can make their absorbent system more efficient and thus keep their glands more active, avoiding the danger of atrophy.

To conclude, modern scientifie evidence is perfectly reliable so far as enforced celibacy of brutish people is concerned. The same would apply to pseudo-Yogins. But for the arguments adduced above according to the modern methods, it would be clear that celibacy would not only help real Yogins to lead a healthy life,[1] but also would enable them to prolong it considerably.

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[1] Patan'jali stands for celibacy of the soul as well as of the body. The long life which is held out here as a prize of celibacy will be available only to those who are pure at heart. Others must suffer. We, however, express our strong disapprobation of the literature that unduly exaggerates the evils of celibacy on the strength of such evidence as is quoted in the objections (*a*) to (*d*).

FREEDOM FROM EMOTIONS

A Physiological Necessity of Yogic Life

By this time it must have been evident to the readers of the Yoga-Mīmāṅsā that Yogic development is based on nerve culture. The ductless glands also play an important part. Upto now we have taken note of Yogic exercises that are only of the lower type. The higher the Yogic exercise the more it concerns itself with the nerves, and the highest type of Yogic exercises work with the nerves and nerves alone on their physiological side. Such being the case a student of Yoga has to see that his nervous mechanism is very healthy and is highly developed. The same is the case with the ductless glands, although in higher Yogic culture they play a far less important part than the nerves.

For the purpose of developing and maintaining a healthy nervous and glandular mechanism, it is not sufficient for a student of Yoga to undergo particular exercises. He has also to see that he does not allow anything to disturb his body and mind that would adversely affect either his nerves or his ductless glands. Among other things emotions are believed to affect both the nerves and the glands very powerfully. The aim of this article is to set forth scientific evidence that would bear out this belief; and thus establish the necessity for a student of Yoga to be free from emotions.

It is worthwhile to state here that it is not only the students of Yoga that require freedom from emotions. Even an ordinary man would be better in health if he develops this freedom. For these emotions, as will be clear from the evidence adduced in the article, disturb not only the nerves and the glands but also the other organs of the body and this leads to disease and premature old age.

A brief reference to the controversy regarding the genesis of emotions, will disclose the intimate relation between

these and the nervous system. William James and some other psychologists assumed that the bodily changes associated with such emotions as grief, fear, rage or love are not evoked as a consequence of the emotions but that the bodily changes follow directly the perception of the exciting fact, that is, a spectacle which causes fear or rage; and that our feeling of the same changes as they occur is the emotion. Others, however, think that emotions are the cause of the physiological changes that are associated with them. Whichever view is correct, it is admitted on all hands that emotions are invariably accompanied by particular physiological changes and that these changes start with the nervous system and spread to the other parts of the organism, affecting them in different degrees according to the nature of the emotions.

Thus if the emotions are violent and sudden they may prove even deadly. The famous surgeon Vesalious dropped dead when he discovered that the dead body he was dissecting was still throbbing with life-blood in the heart. He was so powerfully overcome by sorrow. Even pleasing emotions may result in death. The deaths of Sophocles and the niece of Leibnitz are cases in point. One of the tragedies of Sophocles was awarded the highest prize. This so much filled him with joy that the emotion proved fatal. The niece of Leibnitz discovered a large amount of gold under the bed of her dead uncle. A terrible emotion of joy seized her and put an end to her life. If the effect of joy is identical with that of sorrow, it is because in both these cases what really takes effect is the surprise, the overwhelming astonishment which is common to both.

When the emotions are not so powerful, but are less violent they may not lead to death, but they may so affect the nervous system that some disease may appear as a consequence. Prof. Naunyn states that after the bombardment of Strasburg in the war of 1870, many cases of diabetes developed in consequence of the fear and anxiety brought about by it.

These disturbances of the nervous system lead to degeneration of the ductless glands which are admittedly

governed by the sympathetic and vagus. Doctors Lorand, Sajous and many others have conclusively proved that the soundness of different vegetative functions depends mainly on these ductless glands; and that if their internal secretions suffer, premature old age and even premature death may follow. Thus emotions through the degeneration of the nervous system and also of the ductless glands prove to be a serious disturbance to the health and progress of a Yogic student. Hence the necessity of securing freedom from these emotions.

As the readers of this journal already know, the most important ductless glands in the body are the thyroid, pituitary, adrenals and the sexual glands. The liver and kidneys have also got their internal secretions. We shall see how these several glands are affected by emotions.

The effect of emotions on the adrenals is to produce higher blood pressure which favours the development of *arteriosclerosis* and other diseases of the circulatory system.

The thyroid is so much affected by mental depression that this emotion is mentioned by scientists as one of the causes of *myxœdema.* This gland is one of the most powerful agencies set up by Nature to protect the body against poisons. A degenerated thyroid means disease and even premature old age, a serious hindrance to progress in Yogic culture.

The pituitary body is also affected by emotions. Prof. Pel and others have noted cases of *acromegaly* after violent emotions. Dr. Sajous has often pointed out this gland as the central organ upon which all strong emotions react.

The liver and kidneys are much affected by emotions. Jondice indicates the disturbance of the former whereas, according to Clifford Albutt, many cases of *interstitial nephritis* can be traced to mental emotions.

Sexual glands are also powerfully influenced by emotions. Cases are often noted where menstruation has sudd-

enly appeared after violent mental shocks. In the case of males mental emotions result, at times, in impotence. We know a very peculiar case in similar connection. The anxiety to secure a pass at the university examination induced emission in a student when the examination paper was set to him. In our therapeutical work we have also come across cases of some youths of clean habits who were rendered impotent simply for the emotion of fear. Some of them had proved themselves to be successful husbands previous to this change.

Besides the ductless glands, other organs of the body such as the heart and the intestines are very largely affected by these emotions.

The effect of fear, anger and similar emotions on the heart is a fact of common experience and needs no scientific demonstration. The case of the intestines stands on a different footing. A layman does not even suspect that his mind is influencing his digestive tube in any way. But experimentation has shown that even this organ is not free from the effects of emotions. Prof. Henderson, an eminent Danish physiologist found that depressing emotions powerfully excite the sympathetic and lead to the inactivity of the intestines. Some persons are unable to move their bowels because they are in a state of *fear* that they cannot. Hertz mentions a curious example of a lady in this respect. Her bowels were abstinately constipated, but she had a good motion when she gave one of her children a dose of caster oil, although the oil produced no effect when she took it herself. This shows that the emotion roused by the sight of the oil and its administration to the child, had a more powerful influence upon her bowels than the oil itself!

Violent emotions lead to sudden changes. Emotions that are less violent, although they do not immediately show any serious disturbances, surely have an injurious effect upon the different systems of the human body.

When we study the whole evidence regarding the adverse influence of emotions on the human organism in general, and the nervous and glandular systems in particular, we at once see the necessity of securing freedom from these emotions for a student of Yoga and even for an ordinary man. It is never possible for a student of Yoga to make any headway in his work, if the peace of his mind is disturbed by these emotions, because they impair the vitality of those very organs through which he wants to develop.

One of the principal aims of the Yamas[1] and Niyamas[2] laid down by Patan'jali as a mental discipline preliminary to Yogic culture, is to obtain this freedom from emotions. Especially the development of contentment leads to a mental attitude precluding the possibility of any serious emotions perturbing the Yogic heart. The result is a perfectly balanced mind, so beautifully described by the Lord in his Celestial Song—

दुःखेष्वनुद्विग्नमनाः सुखेषु विगतस्पृहः ।
वीतरागभयक्रोधः स्थितधीर्मुनिरुच्यते ॥ [3]

1 See p. 138 of this number

2 शौचसंतोषतपःस्वाध्यायेश्वरप्रीणधानानि नियमाः । P.Y.S. II 32.

Purification, contentment, mortification, study, and worship of God, are the Niyamas.

3 A thinker is said to be balanced in mind, when freed from love, fear or rage, pains cease to deject him and pleasures cease to attract him.

A CAUTION

WHEN we first started the journal, we wanted to make it more theoretical than practical. But we now find that thousands are using it as a practical guide in the study of Yoga. Being conscious of this fact, we are giving cautions against the improper use of an exercise whenever a new practice is described. This has worked well. Not only people have not taken up any new Yogic exercises rashly but several have abandoned the Yogic exercises that they were already doing through ignorance.

In spite of this gratifying circumstance, we want to give a special caution to our readers against *rashly* taking to Prāṇāyāma which we propose to discuss in this volume from the next number. The exercises of Prāṇāyāma directly work upon the nervous system and a wrong use of these is very likely to lead to dangerous consequences.

We quote below two paragraphs from *The Occult Review*, a monthly magazine published in England. We do not accept whatever is said there about Yoga, except the caution that is pronounced so clearly. Whatever is said in this Review of the Westerner also applies more or less to the educated Indian who is almost a copy of that model.

We assure our readers, however, that no untoward results will follow their practising the Yogic exercises detailed in this journal if the the cautions that will be given from time to time are carefully borne in mind and the technique is strictly adhered to. We expect to make the Yoga-Mīmāṅsā a thoroughly safe guide even in the case of Prāṇāyāma or any other higher exercise. The Review says—

"Western students are frequently much concerned with regard to the application of practical methods to occult self-development. After much reading of theoretical treatises and descriptions of the astral and devachanic planes by

those who claim to be able to function upon them in full consciousness, the inquirer naturally starts wondering why he should not essay an experimental investigation of the subject on his own account. With no knowledge other than that gained from the reading of occult and mystical literature, and without stopping to analyse his motives, he decides to embark upon a course of personal effort. As a natural sequence it follows that the line of least resistance is taken and the psycho-physiological practices of the Eastern Yoga systems, which have been made so easily accessible to the West, are adopted with a zeal of which sheer ignorance is the parent. Seldom is the fact realised that the methods which are suited to the Eastern temperament and constitution may not only be less effective but actually harmful if applied by the Westerner with the dynamic vigour which characterises the races of the Occident. In the vast majority of cases, fortunately, the efforts of the investigator are abandoned before any effects are apparent. The Western temperament, accustomed to intense activity in spells of short duration, failing to see any sign of the expected results, is easily convinced that there is nothing in it. Occasionally, however, an unusually sensitive type of nervous organisation becomes almost immediately responsive to these processes, and, to the alarm of the experimenter, strange symptoms make their appearance. Hysteria, nervous instability, and other undesirable conditions are danger-signals which the cautious student takes care not to ignore. If, in spite of this the practices are still pursued, serious disorders of the nervous system, most difficult, if not impossible of cure, henceforth harass the life of the unfortunate and misguided researcher.

"It is not matter for surprise that, left to his own resources and unaware of the dangers lurking in the background, one of the most obvious practical paths should thus be chosen. A little reflection on the conditions involved and the possibilities which lie before the would-be practical occultist may save a vast amount of error and misunderstanding, or even future suffering."

Miscellaneous

DISEASES TREATED AT THE ĀS'RAMA

1 *Constipation.*
2 *Dyspepsia.*
3 *Head-ache.*
4 *Piles.*
5 *Heart-disease (functional).*
6 *Neuralgia.*
7 *Diabetes.*
8 *Hysteria.*
9 *Consumption.*
10 *Obesity.*
11 *Sterility (certain types).*
12 *Impotence.*
13 *Appendicitis, &c.*

YOGA AND THE U. P. GOVERNMENT

All those that are interested in Yogic culture will be pleased to note that the Government of the United Provinces are seriously considering the possibility of introducing Yogic exercises in their schools and colleges. With a view to estimate the scientific worth of the Yogic exercises as they are being developed and formulated by the Kaivalyadhāma, and to get a report on the possibility of their being introduced in the educational institutions of the United Provinces, the Government of those provinces deputed their Assistant Director of Public Health, Dr. A. Sousa, F. R. C. S. (Edin.), D. P. H. (Ire.), to the Ās'rama last summer. The learned doctor spent two weeks with us and carefully went into the theoretical and practical details of the Yogic Physical Culture. It gives us great satisfaction to note that the report has been favourable. Only a week ago we were informed that the Director of Public Health of the United Provinces has recommended the introduction of the Yogic exercises to the Government and that his recommendations are receiving the attention of that Government. We are sure our readers will join us in sincerely thanking the U. P. Government for this their move and wishing that the recommendations of the Public Health Department would finally meet with their approval.

YOGA AND PANDIT MALAVIYAJI

The Hon'ble Pandit Madan Mohan Malaviya, M. L. A., Vice-Chancellor, Hindu University, Benares, honoured the Ās'rama with a visit on the 8th of June. At our request he also addressed the inmates of the Kaivalyadhāma on that occasion. A report of this event appeared through the Associated Press Service in different papers. It ran as follows:—

"LONAVLA, June 8.

"Pandit Madan Mohan Malaviya visited the Kaivalyadhama, an institution established in 1924 for the study of Yoga in its physical and spiritual aspects by Shrimat Kuvalayananda whose former name was Mr. Gune and who was the Principal of the Amalner National School. Pandit Malaviya who has recently taken to Yoga exercises regards the institution as unique and was particularly pleased that it was working on strictly scientific lines taking nothing on trust. He discussed with its founder the practicability of using Yogic exercises as a basis for building up the physique and character of the young men of India.

"Yesterday the Pandit addressed its inmates when he expressed his fullest faith in the efficacy of Yoga as a system of Therapeutics and Physical Culture and as a means for the highest spiritual uplift of humanity. He was delighted with the valuable work that had already been done by the Kaivalyadhama and hoped the institution would be placed on a permanent basis. —A. P."

Panditji stayed in Lonavla upwards of a week. Nearly everyday he had discussions with us about Yoga. One of the aims of these discussions was to explore the avenues through which Yogic culture could be made universal. Panditji also tried to understand the possibility of our co-operation with the Hindu University in case Yogic culture were introduced there as a matter of systematic training. We hope in the fulness of time we shall be able to report something agreeable to our readers in this connection. Panditji has very kindly consented to inaugurate the *Parṇas'ālā Lecture Series* which is to be started under the auspices of the Kaivalyadhāma some time after this monsoon. The programme of this series thus far fixed appears on the next page.

THE PARṆAS'ĀLĀ LECTURES SERIES

In order to find an occasion for the inmates of the Ās'rama to come in direct touch with the thinkers engaged in different fields of human activities, and also to give the Ās'ramites an opportunity to understand the view-point of these thinkers regarding spiritual culture with reference to their respective fields, we wish to institute a series of lectures called the *Parṇas'ālā Lectures Series.* With a view to extend the usefulness of these lectures, we propose to publish them on behalf of the Ās'rama for the benefit of the general public. As stated on the last page the Hon'ble Pandit Madan Mohan Malaviya, M. L. A., Vice-Chancellor, Hindu University, Benares, has very kindly consented to inaugurate this series. Some other gentlemen also have highly obliged us by accepting our request for a discourse. We have great pleasure in announcing the names of the gentlemen who have thus far kindly undertaken to speak.

Mr. Chintaman Vinayak Vaidya, M.A., LL.B.,
POONA.

Mr. Govind Sakharam Sardesai, B.A.,
Author of *A History of Modern India,*
KHANDALA, Poona.

The Hon'ble Pandit Hridayanath Kunzaru, M. L. C.,
ALLAHABAD.

The Hon'ble Pandit Madan Mohan Malaviya, M. L. A.,
Vice-Chancellor, Hindu University,
BENARES.

The Hon'ble Mr. Narsinha Chintaman Kelkar,
M. L. A., POONA.

Prof. Ramachandra Dattatreya Ranade, M. A.,
Allahabad University, ALLAHABAD.

Prof. Shivaram Mahadev Paranjape, M. A.,
POONA.

RANA NATAVARSINGH CLINICAL LABORATOY

This Laboratory was started in October 1926 and has been associated with the royal name of H. H. The Maharaja Rana Saheb of Porbandar, with his consent, out of gratitude for the patronage His Highness has been graciously giving to the Ās'rama. It is directly in the charge of the House Surgeon of the Ās'rama, Dr. B. M. KADKOL, M. B. B. S., Ophthalmologist and Bacteriologist. Physical, chemical and microscopic tests are instituted in this Laboratory and are offered gratis to everyone presenting himself for clinical examination.

Although this Laboratory is primarily meant for the indoor and outdoor patients of the Ās'rama, it has been thrown open to the general public, also free of charge. It is not binding upon persons presenting themselves for examination from outside to follow the Yogic treatment. They are free to place themselves under any medical man outside the Ās'rama for whatever treatment they like.

HOURS OF ATTENDANCE

8 A. M. To 11 A. M. **4 P. M. To 5 P. M.**

N. B.—Work during extra hours will be done only for very urgent cases.

Lonavla,
16-9-1928.

Kuvalayānanda,
DIRECTOR, KAIVALYADHĀMA,

KAIVALYADHAMĀ

HOURS OF BUSINESS

Director's Office

9-30 A. M. TO 11-30 A. M. 1 P. M. TO 1-30 P. M.
6 P. M. TO 6-30 P. M.

House Surgeon's Office

8 A. M. TO 11 A. M. 4 P. M. TO 5 P. M.

Yoga-Mīmāṅsā Office

9 A. M. TO 11 A. M. 1 P. M. TO 6-30 P. M.

Demonstrator's Room

8-30 A. M. TO 11-30 A. M.

Rana Natavarsingh Clinical Laboratory

8 A. M. TO 11 A. M. 4 P. M. TO 5 P. M.

Reading Room

8-30 A. M. TO 11-30 A. M. 1 P. M. TO 6-30 P. M.

REQUEST TO VISITORS

1 Visitors are requested to get their business done during the office hours only. Prompt and business-like methods are recommended.

2 All inquiries should **first** be made at the Yoga-Mīmāṅsā Office.

3 The Director is always hard pressed for want of time. Visitors are therefore, requested to finish their business in the shortest time possible. No interview should exceed 15 minutes. In case a longer interview is desired, the visitor is requested to get a special appointment with the Director for the time he wants.

KUN'JAVANA,
September 16, 1928.

MANAGER, KAIVALYADHĀMA.

AN APPRECIATION

THE LOKASHIKSHANA

Poona, *June 1928.*

In ancient times the Yogis of Āryāvarta prescribed certain Āsanas and other means for the physical and spiritual benefit of man. Forgetting the science at the back of the principles, we had chosen to our shame merely to sing the praises of our forefathers, to which nobody would listen in this age of reason and experiment. It is a matter of great congratulation and satisfaction in such circumstances that S'rīmat Kuvalayananda by the grace of his Guru was inspired to undertake the task of of investigating Yoga in the light of modern scientific methods and principles. Accordingly he is now presenting in his Quarterly Journal to our modern scientists his experience and conclusions in connection with a critical and comparative study of the various physical poses and psychic states in Yoga in the light of modern sciences of body and mind. It is obvious from his researches so far published how the Indian Yogic Lore can brilliantly and gloriously bear all the tests of modern science of the West.

S'rīmat Kuvalayānanda's undertaking is unprecedented, of great scientific and philanthropic significance. He is charged, single-handed as he is, with the grave responsibility of maintaining the venture. We very much wish his journal and his institution large popular support, long life and the facilities of work.

तदेकोऽवशिष्टः शिवः केवलोऽहम् ।
I alone persist : Blissful : Absolute.

ॐ

सोऽहम् ।

Yoga-Mimansa

सर्वं खल्विदं ब्रह्म ।
All this is, indeed, Brahman.

नेह नानास्ति किञ्चन ।
There is nothing here apart from it.

EDITED BY

S'RĪMAT KUVALAYĀNANDA

(J. G. GUṆE)

July-October 1928

Vol. III **Nos. 3 & 4**

KAIVALYADHĀMA

Post—LONAVLA

(BOMBAY - INDIA)

शरीरमाद्यं खलु धर्मसाधनम् ।
Surely Health is the primary requisite of spiritual life.

Printed by : 1. Manilāl Itchhārām Desāi at 'The News Printing Press',
20-24 Bake-House Lane, Medows Street, Bombay No. 1,
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(117 Valvana), Lonavla, G. I. P. (Bombay-India).

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Fig.

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तदेकोऽवशिष्टः शिवः केवलोऽहम् ।

सोऽहम् ।

YOGA-MĪMĀNSĀ

VOL. III JULY-OCTOBER, 1928 NOS. 3 & 4

Editorial Notes

MAY the Maker of all make this journal a success. Blessed is the name of the Lord. May He bless the workers of the Ās'rama with a happy and prosperous career as servants of the world which is only the Lord Himself objectified. May He, that has created us in His infinite wisdom, lead us to the light that is beyond all darkness.

⚜ ⚜ ⚜

WITH the issue of this joint number, volume three of the Yoga-Mīmānsā is completed. We have to offer our sincere apology to the subscribers for the extreme irregularity occurring in our publication. We have been trying our level best tc introduce punctuality in the issue of this journal. Unluckily we have failed thus far. We wish, however, to make another serious attempt at punctuality in our publication of the Yoga-Mīmānsā. The present issue in its combined form, is an indication of this attempt. By the time we finish the fourth volume, if we find that this very irregularity continues, we shall introduce a new arrangement in the publication of this journal. It will be such as would not keep our readers waiting for every issue. So to-day what we sincerely request the subscribers is to excuse us for the irregularity that has become a general rule in the appear-

ance of this magazine. We assure our readers that they will not have to put up with it much longer.

⚜ ⚜ ⚜

When we began the third volume, we wished to publish in it our researches on the treatments of dyspepsia, piles etc., although the main theme of the volume was to be Prāṇāyāma. As our readers will find after the perusal of this joint issue, Prāṇāyāma has taken up all the space at our disposal. We could, therefore, give no attention to the other subjects proposed to be treated in this volume. The arrangement of matter appearing in volume four, as we contemplate it to-day, does not leave much scope for articles on subjects other than Prāṇāyāma. We are afraid all the four numbers of the fourth volume will be *mainly* covered by an exhaustive treatment of Prāṇāyāma in its different aspects. We do propose to take up the subjects like dyspepsia, piles etc., as early as possible; and may spare a few pages for these even in the next volume.

When we started the Yoga-Mīmāṃsā it was never intended to be used as a text-book for the practice of Yoga either in its physical or its spiritual aspect, although provision was made therein for information useful to a practical student of Yoga. Soon after the first issue of this journal came out, we found that people felt so much attracted by the detailed technique of various Yogic practices given in this magazine that it began to be used as a very trustworthy text-book for the practice of Yoga. As the matter stands to-day, the Yoga-Mīmāṃsā has become an authoritative text with many students of Yogic culture, spiritual as well as physical. Prāṇāyāma occupies a very important place in the Yogic curriculum of every student, whether his aim is physical or spiritual. Realizing this position of Prāṇāyāma, we have been treating the subject in a way that would be useful to both the types of students.

We have to request our readers to note, however, that the journal cannot change its character. It has to main-

tain its level as a research journal. We cannot lower it to the position of a propagandist paper. Hence much of the information which the popular mind would like to find in the Yoga-Mīmāṅsā, will not be available here. We cannot make even a single statement without having scientific evidence to support it. In spite of all these difficulties, we are trying to make this journal as useful as possible even to a practical student of Yogic spiritual culture.

⚜ ⚜ ⚜

It is very painful to be required to write the following few lines about the exploitation of our researches. All over India a set of irresponsible people has arisen that is taking undue advantage of our publication. Some of these people pass our researches as their own. Others take some of our research work, mix it up with something that they have to say, and present this patchwork to the public, with references to the Yoga-Mīmāṅsā in several places. The most irresponsible of the lot are people who have actually translated into some vernacular our articles appearing in the Yoga-Mīmāṅsā, without our knowledge, much less without our permission. All these people have brought out cheap literature which is finding easy circulation in the public.

Our objections to this procedure are manifold. First of all, due to a want of proper physiological and Yogic knowledge, what these people offer to the public is not always harmless. References to the Yoga-Mīmāṅsā lend this literature the appearance of being authoritative. We are of opinion that the publication of such literature is doing disservice to the public. Secondly we are sure the authors of this type of literature are committing a breach of ordinary moral discipline. None of them has had the goodness of acquiring our formal permission for using our researches. Thirdly we are afraid some of these people are going against the provisions of law available in this regard. When we publish the Yoga-Mīmāṅsā, all rights are reserved to ourselves. We are getting expert legal advice on this point,

and we shall not hesitate to take the necessary steps to vindicate our rights in this connection.

⚜ ⚜ ⚜

We have great pleasure in drawing the attention of our readers to literature that is appearing in the Miscellaneous Section. At the beginning of 1929 two important activities were started under the auspices of the Ās'rama. An organization based upon democratic principles, was brought into existence for the spiritual service of humanity. This organization is called *The Kaivalyadhāma Spiritual Service.* This is, perhaps, for the first time that democracy is introduced in the field of spiritual culture in India. Up to now Indian spiritual institutions had had a patriarchal form of government. A perusal of the literature about the Kaivalyadhāma Spiritual Service given in the last Section here, will show that the constitution of this body is thoroughly democratic. Although this is quite a new experiment, S'rimat Kuvalayānanda, the First Member of this Service, hopes to make it a success by the grace of God and by the blessings of his Master. This organization offers excellent field for the activities of the spiritually minded sons of India who are anxious to work for the all-sided uplift of humanity. We sincerely request our readers to give wide circulation to this information among the ardent souls that they may know of.

People are admitted to Spiritual Service only when they are duly qualified for carrying on the highly responsible work for which the body is organized. The products of the Indian Universities are not capable of directly taking up this work. Hence arrangements are made at the Kaivalyadhāma for giving the necessary training to graduates and under-graduates that seek admission to the Spiritual Service. *The Mādhavadāsa Academy of Spiritual Culture* is founded for training up the intending members as probationers. In the Miscellaneous Section information regarding the Academy has also been given. Evidently the success either of the Academy or of the Spiritual Service will depend upon the quality of people that join these bodies. We

are sure Indian youths will not fail to take advantage of the training facilities and the opportunities for spiritual work which the Kaivalyadhāma offers.

Two articles from the pen of Mr. N. B. Pandya appear at the end of the Miscellaneous Section. Mr. Pandya stayed at the Ās'rama for a few weeks and has recorded his impressions in several articles, two of which are reproduced here from *The Bombay Chronicle.* These articles are a good commentory on the doings of the Ās'rama. Hence they are included in this issue.

⚜ ⚜ ⚜

THE extreme delay always occurring in the publication of the Yoga-Mīmānsā, has made some people anxious about the existence of this journal. Let us assure our readers that the publication will not cease, so long as the Ās'rama is there. The timings may change but not the nature of this magazine.

As stated in one of the foregoing notes, the fourth volume is intended to be published according to the present arrangements. The first number of that volume will be posted to our subscribers in the first week of either April, or May 1930. Each of the subsequent numbers will be issued at the interval of three months thereafter. Detailed instructions in this connection will be found on page 322. We have to very earnestly request our subscribers to send us definite information about their intention to continue or discontinue, on the printed card that is being circulated herewith. If any subscriber fails to send any instructions, it will be taken for granted that he wants to continue and desires us to recover his subscription by sending the first issue of the next volume per V. P. P.

It is a very painful circumstance that some of the subscribers do not send us any information, and when a V. P. Packet is sent to them they reject it. A little attention on the part of these people will save us a loss of several rupees, a loss which does not benefit the subscriber at all.

Hence we have to request every subscriber to give us precise information in time regarding his intention.

⚜ ⚜ ⚜

We are conducting this journal at a tremendous sacrifice. The researches published in this magazine are valued by different men of science and are required to be carried on at a heavy expenditure. It is acknowledged on all hands that the Kaivalyadhāma research work has splendidly added to the glory of Yoga-S'āstra. We unhesitatingly acknowledge that the subscribers of the Yoga-Mīmāṅsā have a large share in the success of the Kaivalyadhāma. Under these circumstances it is not too much to expect all our readers to try their best to get a larger patronage to the Yoga-Mīmāṅsā. We are sure the present subscribers will condone our irregularity and will continue their support during the years to come.

⚜ ⚜ ⚜

May the Lord that enabled us to found the Ās'rama, give us strength enough to carry on its work ! May He ever widen the circle of our sympathizers and thus allow us to serve Him and His children to the best of our ability !

The Scientific Section

ॐ

The Kaivalyadhama Spiritual Service

and

The Madhavadasa Academy of Spiritual Culture

afford the best opportunities for Spiritual and Intellectual training followed by well organized and all-sided spiritual work for the uplift of mankind. Will Indian youths avail themselves of these facilities at the Kaivalyadhāma to qualify themselves for the Service of the Lord ?

X-RAY EXPERIMENTS ON THE DIAPHRAGM AND THE RIBS

(Continued)

In our last issue in the preface of the 'X-Ray Experiments on the Diaphragm and the Ribs', we have made the following remark:—

"It may be urged with some show of truth that the actions studied in the following experiments are *abnormal* and hence the findings would not hold good in the case of normal actions. In the next issue we shall publish evidence bearing on actions falling within normal range."

The following six experiments were performed with a view to study the movements of the diaphragm and the ribs within this normal range. In this connection the following four points deserve our attention.

i The upward normal range of the moving ribs is indicated by the space through which they rise during normal inspiration, that is, after normal expiration.

Thus if the ribs are raised after ordinary expiration, they will move up through their upward normal range, whether this is done with or without stopping one's breath is immaterial. Hence Experiment VII records the position of the ribs after they have moved through their upward normal range, because the experiment was performed when the ribs were raised after normal expiration.

ii The downward normal range of the moving ribs is indicated by the space through which they sink during normal expiration, that is, after normal inspiration.

Thus if the ribs are lowered after ordinary inspiration, they will move down through their downward normal range, whether this is done with or without stopping one's breath is immaterial. Hence Experiment XI records the position of

the ribs after they have moved through their normal downward range, because the experiment was performed when the ribs were lowered after normal inspiration.

iii The upward normal range of the moving diaphragm is indicated by the space through which it rises during normal expiration, that is, after normal inspiration.

Thus if the diaphragm rises after ordinary inspiration, it will move up through its normal upward range, whether this happens with or without stopping one's breath is immaterial. Hence Experiment X records the position of the diaphragm after it has moved through its normal upward range, because the experiment was performed when the diaphragm was raised after normal inspiration.

iv The downward normal range of the moving diaphragm is indicated by the space through which it sinks during normal inspiration, that is, after normal expiration.

Thus if the diaphragm sinks after ordinary expiration, it will move down through its normal downward range, whether this happens with or without stopping one's breath is immaterial. Hence Experiment VIII records the position of the diaphragm after it has moved through its normal downward range, because the experiment was performed when the diaphragm was lowered after normal expiration.

From the foregoing four paragraphs it will be clearly seen that the movements of the diaphragm and the ribs as they are studied in the following experiments are all within the normal range. Hence the findings based upon these experiments must be valid even from the normal physiological point of view.

EXPERIMENT VI

OBJECT OF THE EXPERIMENT :—

The object of the experiment was to record the relative positions of the diaphragm and the ribs, after normal expiration, with a view to compare and contrast them with their relative positions (*a*) after raising the ribs through their normal upward range; and also (*b*) after lowering the diaphragm through its normal downward range.

PREPARATION OF THE SUBJECT :—

The subject was a young man of twenty-nine. He was quite healthy and had mastered Uḍḍiyāna and other abdominal exercises. On the noon previous to the day of experiment, he had had his usual meal. In the evening he did not take even a cup of milk and retired without any laxative. In the morning at about 6 o'clock he had his colon flushed with four pints of tapid water. The experiment started at about 10–30 a. m. As the experiment was to be made with the diaphragm and the ribs, no other preparation was necessary.

THE EXPERIMENT PROPER :—

For being skiagraphed the subject was made to sit on a stool, with his legs resting on the cross-bars of the same stool below. The X-Ray plate was fixed on a stand in front of his chest and abdomen quite close to these parts. The tube was arranged at the back of the subject. The distances between the plate and the subject, and the subject and the tube, were maintained uniform throughout this and the five experiments that follow.

The subject then held his breath after ordinary expiration. The radiograph taken in this position has been shown in Fig. XLII. Fig. XLIII gives the line drawing of the same.

NOTE—

The radiographs printed in this issue were all originally 8″ × 12″. They have been subsequently reduced to suit the size of this journal.

REFERENCES TO RADIOGRAPH X

1_9 The Ninth Dorsal.

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

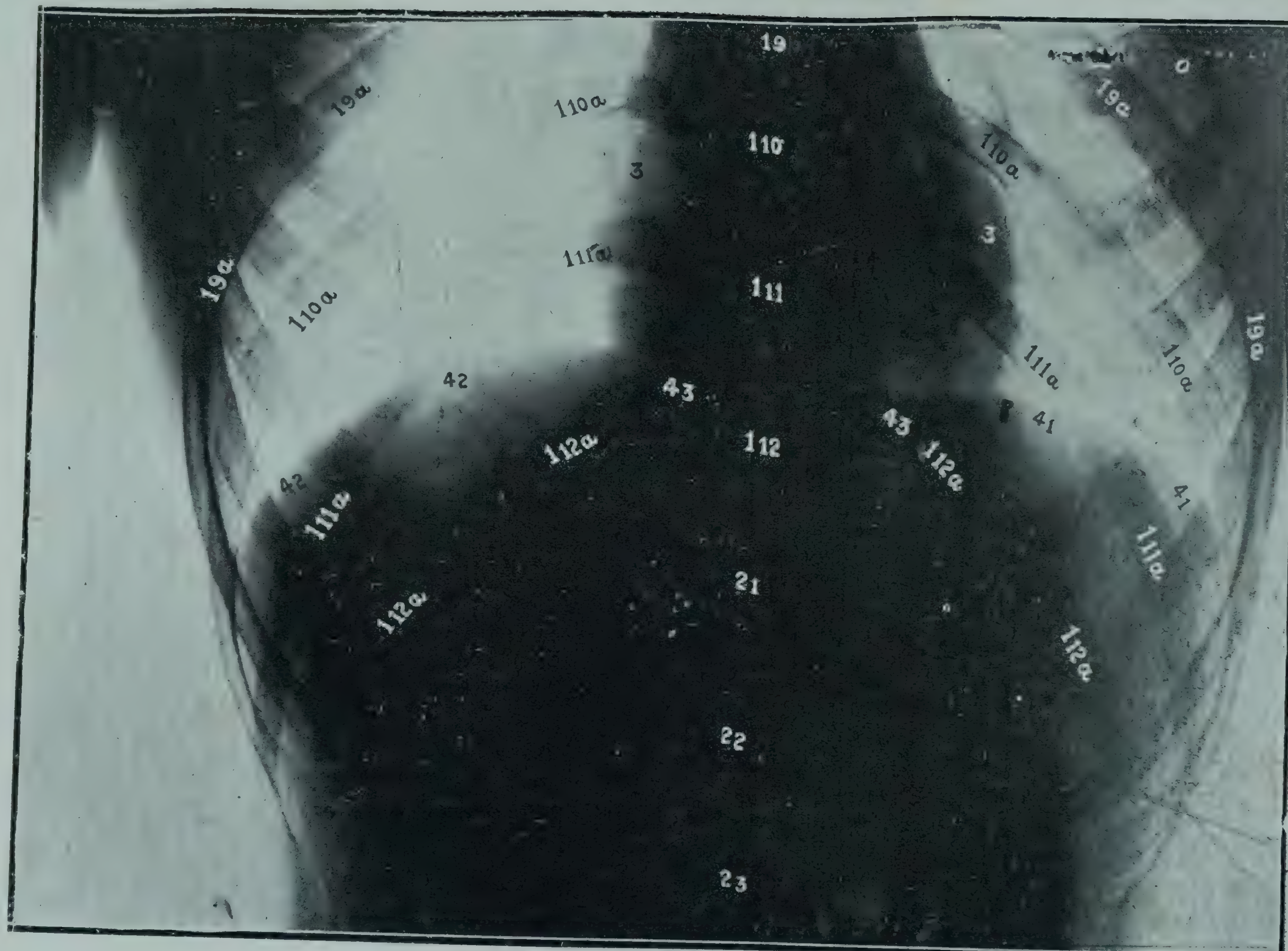
3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

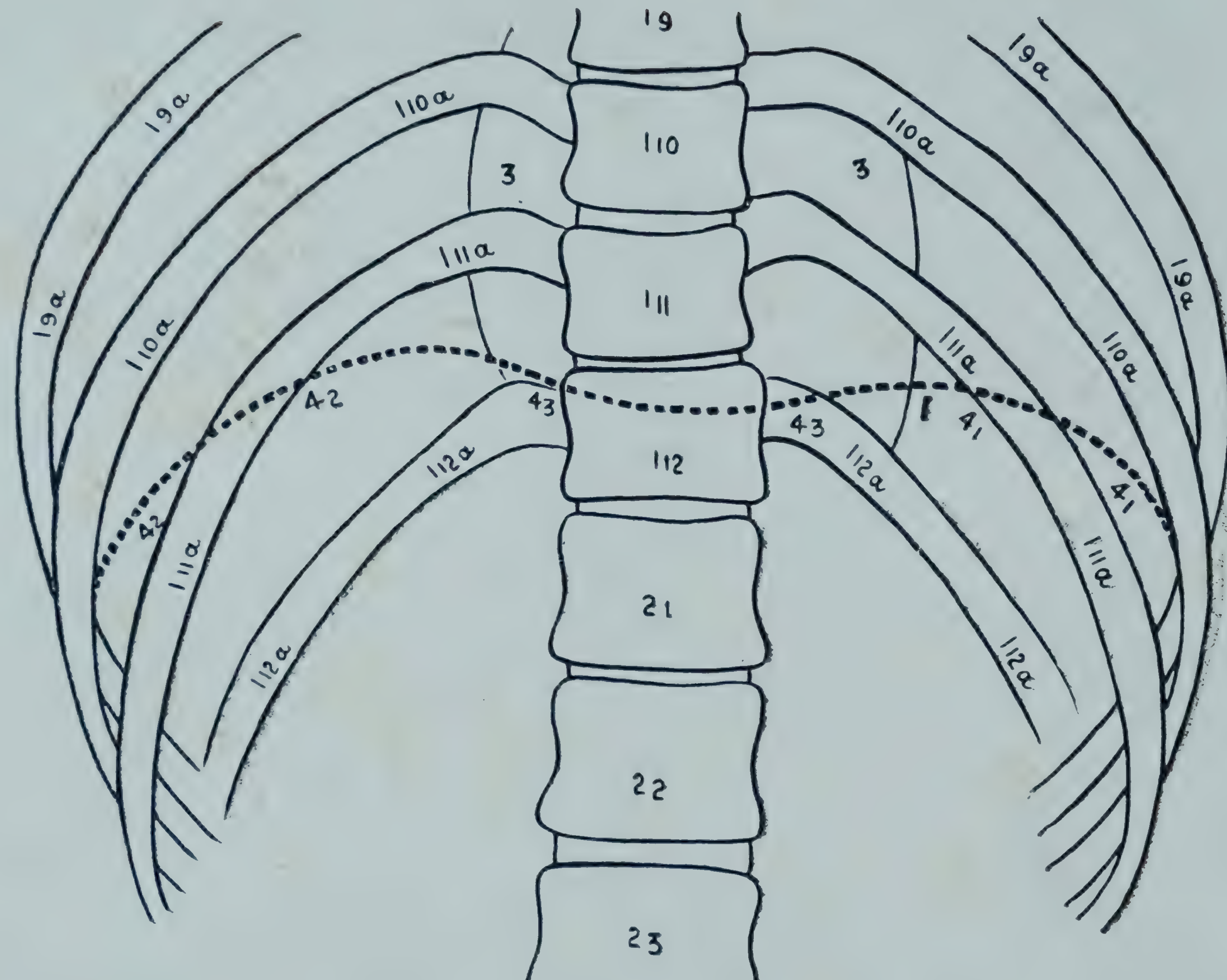
4_3 The Central Tendon.

Fig. XLII *Radiograph X*



Relative Positions of the Diaphragm and the Ribs
after
Ordinary Expiration

Fig. XLIII



Line Drawing of *Radiograph X*

REFERENCES TO RADIOGRAPH X

1_{9} The Ninth Dorsal.

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_{1}, 2_{2}, 2_{3}, The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_{1} The Upper Margin of the Left Dome of the Diaphragm.

4_{2} The Upper Margin of the Right Dome of the Diaphragm.

4_{3} The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

POINTS OF STUDY :—

1 — (a) The radiograph as it is produced here covers the last four dorsal vertebræ and the first two lumbar. Only the upper portion of the third lumbar is visible.

(b) The ninth, tenth and eleventh dorsal are shadowed by the heart, whereas the twelfth dorsal and the lumbar vertebræ are covered by the diaphragm.

(c) Almost the whole of the heart is to be clearly seen in the picture.

(d) Only portions of the ninth ribs are included in this radiograph. The tenth, eleventh and twelfth ribs are visible in their entirety.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome rises slightly above the level of the lower border of the eleventh dorsal.

(c) The shadows of the right half of the diaphragm extend beyond the eleventh right ribs, so as to touch and perhaps even to cover a part of the lower portion of the tenth right rib.

3 — (a) The left dome rises up to slightly below the level of the upper border of the twelfth dorsal.

(b) The shadows of the left half of the diaphragm extend beyond the eleventh left rib so as to touch and perhaps even to cover a part of the tenth left rib.

(c) As usual the right dome rises a little bit higher than the left dome.

4 — (a) The central tendon lies across the upper half of the twelfth dorsal, and marks the usual downward depression towards the left.

(b) Although the middle of the central tendon is not to be clearly seen, being mixed up with the shadows of

the heart, its position is clearly indicated by the outlines of its extremities.

5 — The distance between the two upper corners of the first lumbar vertebra is 4.5 cm.

6 — The distance between the outer borders of the eleventh ribs across the upper margin of the first lumbar is 20.5 cm.

7 — The distance between tho inner borders of the tenth ribs across the upper margin of the first lumbar is 22.5 cm.

8 — The convexity of the two diaphragmatic domes and of the costal arches should be carefully noted so that it can be compared with their convexity in the next experiment.

EXPERIMENT VII

OBJECTS OF THE EXPERIMENT :—

One of the objects of the experiment was to record the relative positions of the diaphragm and the ribs after the latter were raised through their normal upward range from their position at the end of ordinary expiration. The other object was to compare these new relative positions of the diaphragm and the ribs with their relative positions as they stood at the end of normal exhalation.

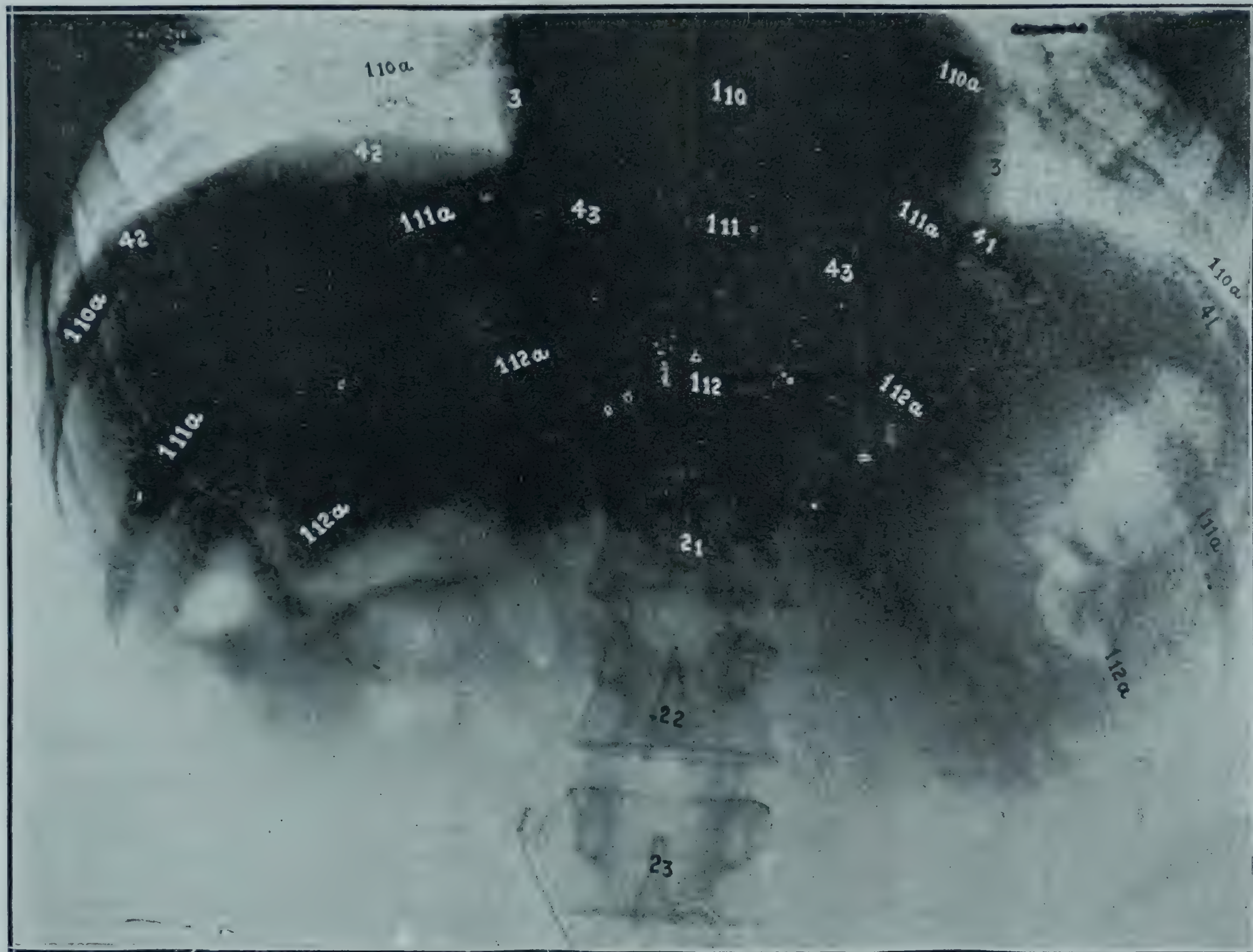
PREPARATION OF THE SUBJECT :—

The same subject as in the last experiment was immediately taken up for this experiment.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. After normal expiration the subject held his breath and raised the ribs, thus making them move up through their upward normal range. The radiograph taken while this upward position of the ribs was being maintained is produced in Fig. XLIV. Fig. XLV gives the line drawing of the same.

Fig. XLIV Radiograph XI



Relative Positions of the Diaphragm and the Ribs
after
The Ribs are Raised through their Upward Normal Range.

REFERENCES TO RADIOGRAPH XI

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

References to Radiograph XI

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_{1}, 2_{2}, 2_{3}, The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

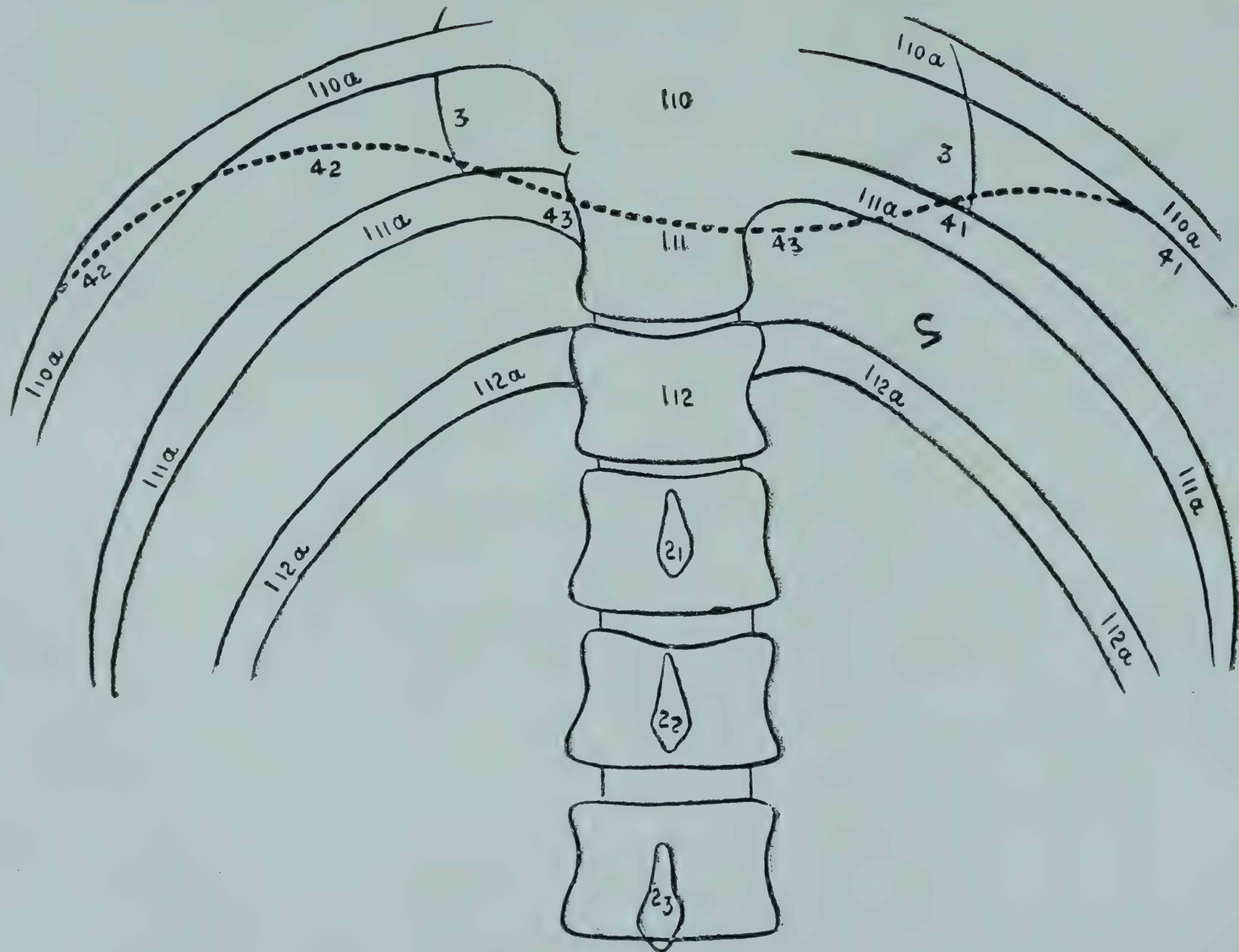
4_{1} The Upper Margin of the Left Dome of the Diaphragm.

4_{2} The Upper Margin of the Right Dome of the Diaphragm.

4_{3} The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XLV



Line Drawing of *Radiograph XI*

POINTS OF STUDY:—

1 — (a) The radiograph as it is produced here covers the last three dorsal and the first three lumbar vertebræ.

(b) The dorsal vertebræ are hidden by the shadows of the central tendon and the heart. The lumbar vertebræ are to be clearly seen in the picture.

(c) The upper portion of the heart has been left out of the radiograph, the lower portion being seen pushed up considerably by the rising diaphragm.

(d) Only a small portion of the tenth left rib has been omitted. Otherwise the tenth and also the eleventh and twelfth ribs are included in the radiograph.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome rises almost to the level of the middle of the tenth dorsal. In the last experiment this dome stood slightly above the level of the lower border of the eleventh dorsal. It means that the right half of the diaphragm has risen through the full height of the eleventh dorsal and half the height of the tenth.

(c) The shadows of the right half of the diaphragm entirely cover the eleventh rib and extend beyond so as to cover completely the lower portion of the tenth. In the last experiment these shadows covered only a fraction of the lower portion of the tenth right rib. This shows that the right dome of the diaphragm has now a larger lateral expansion than previously. This larger lateral expansion becomes more evident when we remember that the ribs themselves are occupying in this experiment a place relatively higher than in Experiment VI as will be presently noticed.

3 — (a) The left dome rises to the level of the upper border of the eleventh dorsal. In the last experiment this

dome stood slightly below the level of the upper border of the twelfth dorsal. It means that the left dome of the diaphragm has risen through the full height of upper part of the twelfth and the whole of the eleventh dorsal.

(b) The shadows of the left half of the diaphragm extend beyond the eleventh rib, so as to cover completely the lower part of the tenth left rib. In the last experiment these shadows covered only a part of the lower portion of the tenth left rib. This shows that the left dome of the diaphragm has now a larger lateral expansion than previously. This lateral expansion becomes more evident when we remember that the ribs themselves are occupying in this experiment a place relatively higher than in the last experiment, as will be presently noticed.

4 — (a) The central tendon lies across the upper half of the eleventh dorsal, and marks the usual downward depression towards the left. In the last experiment the central tendon lay across the upper half of the twelfth dorsal. It means that the central tendon has risen through the full height covered by the upper half of the twelfth and the lower half of the eleventh dorsal.

(b) Although the whole of the central tendon is not to be clearly seen in the accompanying picture, it is visible in the original radiograph Even here its position is clearly indicated by the outlines of its extremities.

5 — Taking the last three points of study into consideration, we find that the whole of the diaphragm has risen in this experiment to a level higher than in the last experiment by the full height of the eleventh dorsal and that this rise is uniform in the different parts of the diaphragm, namely, the right dome, the left dome and the central tendon,

6 — The distance between the two upper corners of the first lumbar vertebra is 4.5 cm. In the last experiment this distance was recorded to be the same. Hence it will be seen that the distances between the plate and the subject and the subject and the tube were the same in this as in the last experiment. It is to be noted that the same subject was exposed to X-Ray in this as in the last experiment.

7 — The distance between the outer borders of the eleventh ribs across the upper margin of the first lumbar is 25.6 cm. This distance measured 20.5 cm. in the last experiment. It means that the eleventh ribs have been so elevated as to increase the lateral capacity of the thorax across the first lumbar by 5.1 cm.

8 — The distance between the inner borders of the tenth ribs across the upper margin of the first lumbar is 27.6 cm. In the last experiment this distance was recorded to be 22.5 cm. It means that the tenth ribs have been so elevated as to increase the lateral capacity of the thorax across the first lumbar by 5.1 cm., a circumstance which confirms the result arrived at in the last paragraph.

9 — A comparison between the convexity of the two diaphragmatic domes and of the costal arches in this and in the last experiment clearly shows that the curves described by the domes and the costal arches are wider in this experiment than in the last. It means there is vertical and lateral expansion in the case of both, the diaphragm and the ribs.

EXPERIMENT VIII

OBJECTS OF THE EXPERIMENT:—

One of the objects of this experiment was to record the relative positions of the diaphragm and the ribs after the former was lowered through its normal downward range from its normal position at the end of ordinary expiration. The other object was to compare and contrast these relative positions of the diaphragm and the ribs with their relative position assumed after normal expiration on the one hand and with their relative positions assumed after normal inspiration on the other. This latter comparison will be made in the next experiment where a radiograph is taken after normal inhalation.

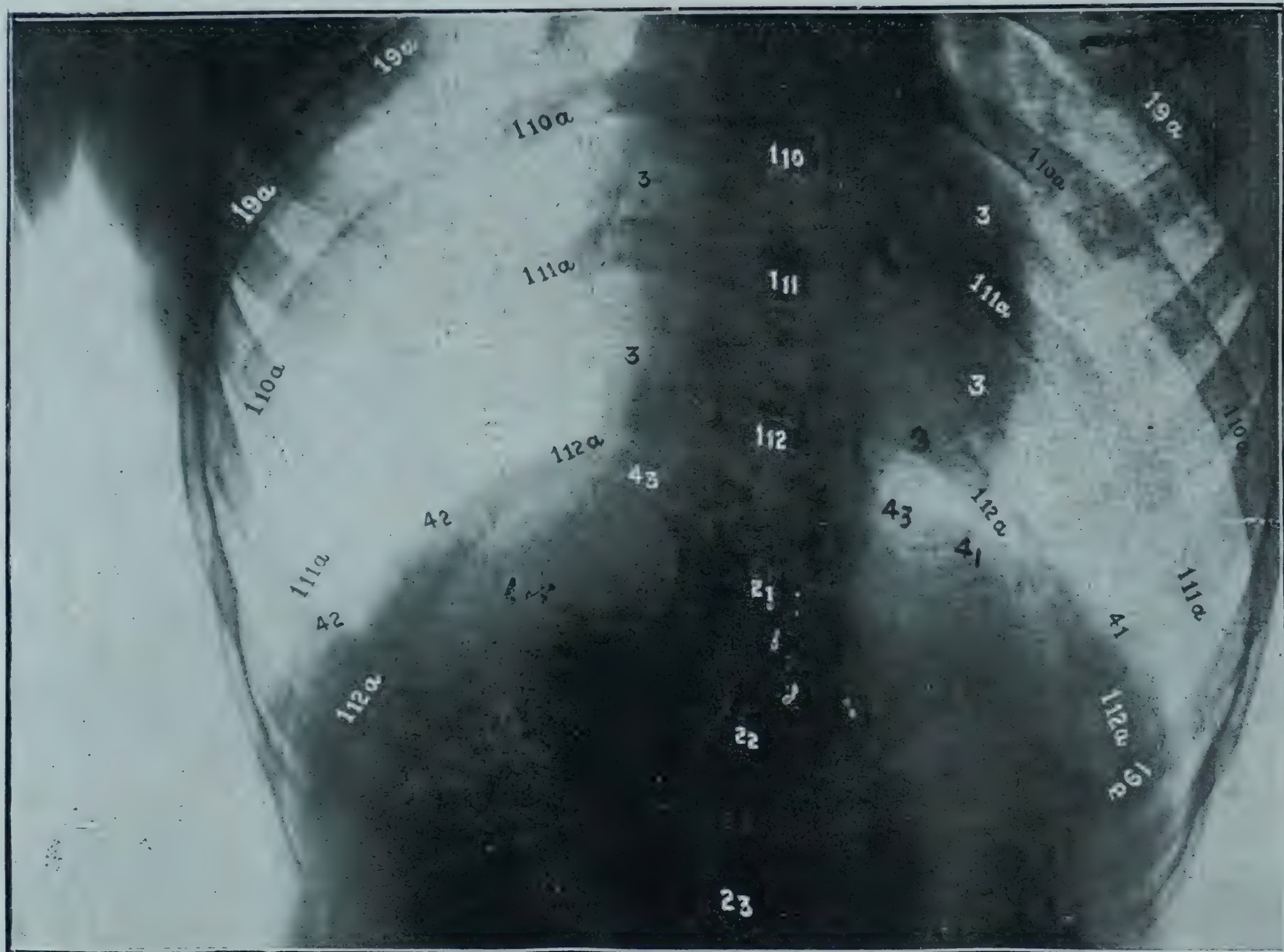
PREPARATION OF THE SUBJECT:—

The same subject as in the last experiment was immediately taken up for this.

THE EXPERIMENT PROPER:—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiments. After ordinary expiration, the subject held his breath and contracted his diaphragm thus lowering it down through its downward normal range, driving the abdominal viscera and the abdominal muscles before it. The radiograph taken when the contraction was completed is produced in Fig. XLVI. Fig. XLVII gives the line drawing of the same.

Fig. XLVI *Radiograph XII*



Relative Positions of the Diaphragm and the Ribs
after
The Diaphragm is Lowered through its Downward Normal Range.

References to Radiograph XII

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

References to Radiograph XII

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

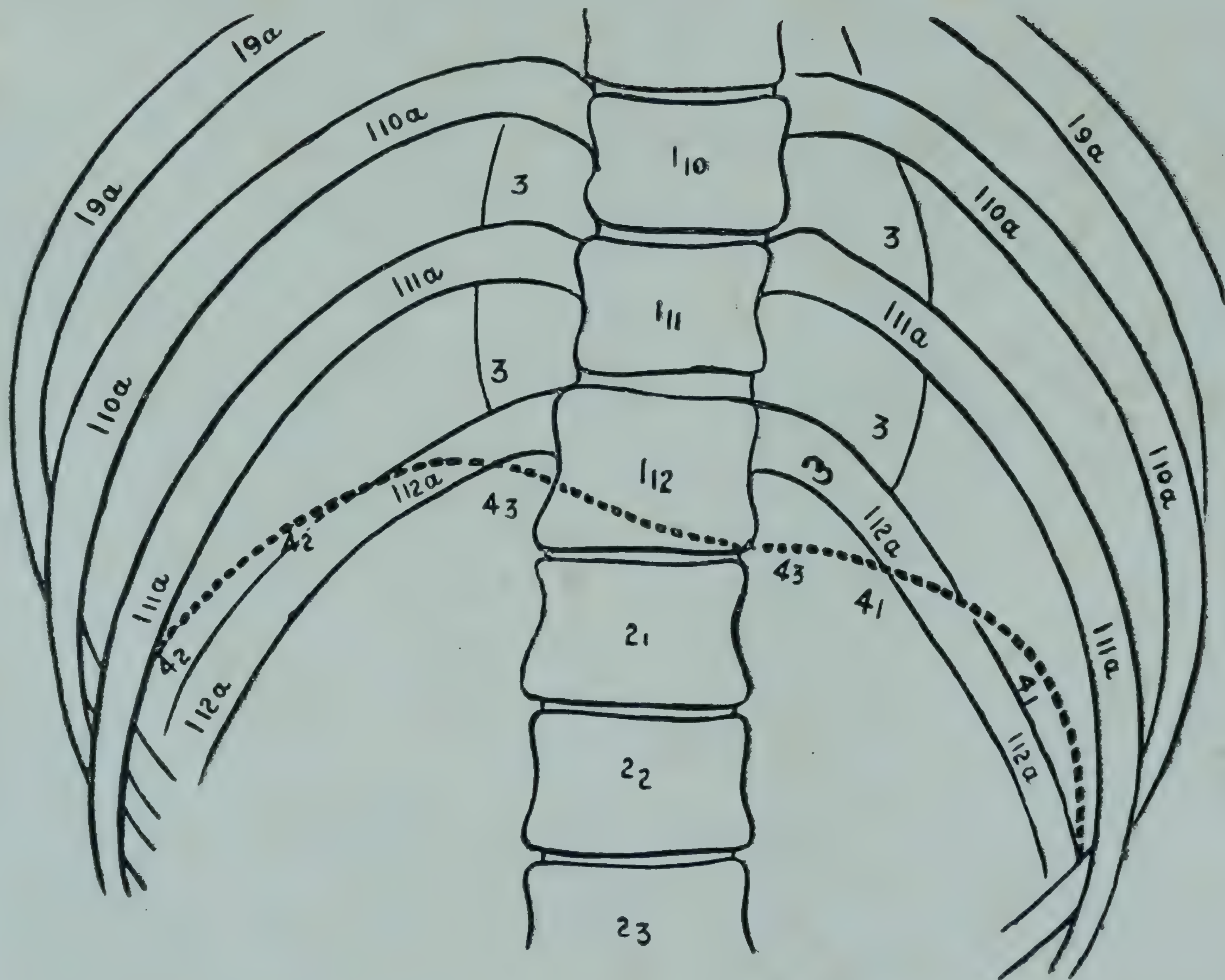
4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XLVII



Line Drawing of *Radiograph XII*

POINTS OF STUDY :—

1 — (a) The radiograph as it is produced here covers the last three dorsal and the first three lumbar vertebræ.

(b) The tenth and the eleventh dorsals are hidden under the shadow of the heart. And the second and the third lumbar are covered by the shadow of the diaphragm.

(c) The heart is almost entirely to be seen in the radiograph except the uppermost portion. Its shadow can be clearly distinguished from that of the diaphragm, the latter in its contracted condition being drawn away from the former.

(d) The ninth ribs are to be seen only in parts. The tenth, eleventh and twelfth ribs are produced in the radiograph in their entirety.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome stands a little higher than the lower margin of the twelfth dorsal. In Experiment VI it stood slightly above the level of the lower border of the eleventh dorsal. It means that the right dome has descended through the height of the lower part of the eleventh and the upper part of the twelfth dorsal.

(c) The shadows of the right half of the diaphragm just cover the twelfth right rib. In Experiment VI these shadows covered not only the lower part of the eleventh right rib but stretching beyond it, encroached upon the tenth right rib. This shows that the right dome of the diaphragm has now a smaller lateral expansion than in Experiment VI. It means that the right dome of the diaphragm has been considerably contracted.

3 — (a) The left dome stands in level below the upper border of the first lumbar. In Experiment VI this dome stood slightly below the level of the upper border of

the twelfth dorsal. It means that the left dome of the diaphragm has fallen in this experiment through almost the full height of the twelfth dorsal.

(b) The shadows of the left half of the diaphragm extend slightly beyond the twelfth left rib. In Experiment VI these shadows extended beyond the eleventh left rib and touched the inner border of the tenth. This shows that the lateral expansion of the left dome of the diaphragm is far smaller here than in Experiment VI. The shrinkage is explained by the contraction of the diaphragm.

4 — (a) The central tendon lies across the lower half of the twelfth dorsal. In Experiment VI it lay across the upper half of this vertebra. It means that the central tendon has sunk down through half the height of the twelfth dorsal.

(b) In this radiograph although the shadows of the heart do not interfere with the shadows of the central tendon, the thick bones of the spinal column again interfere with the visibility of the margin of the central tendon. Its level, however, ean be dimly seen across the spine.

5 — Taking the last three points of study into consideration we find that the diaphragm in this experiment has descended considerably from its position indicated in Experiment VI. This descent of the diaphragm indicates its contraction. It is to be noted that the central tendon has not moved down in exact proportion with the two domes. The contraction of the latter being more complete than that of the former. The shrinkage in the lateral capacity of the diaphragm as seen in this experiment compared with Experiment VI, is also due to the contraction of the diaphragm.

6 — The distance between the two upper corners of the first lumbar vertebra is 4.5 cm. In the last two experiments this distance was recorded to be the same.

Hence it will be seen that the distances between the plate and the subject on the one hand and the subject and the tube on the other, were the same in this as in the last two experiments. It is to be noted that the same subject was exposed to X-Ray in this experiment as in the last two.

7 — The distance between the inner borders of the tenth ribs across the upper margin of the first lumbar is 22.5 cm. This distance is the same as measured in Experiment VI in this connection. It means that in this experiment the tenth ribs have neither sunk nor risen from their positions in Experiment VI. The same may be said about the twelfth ribs because in the present experiment the distance between the outer borders of the twelfth ribs measured across the upper margin of the first lumbar, is 13 cm., the same as the corresponding distance in Experiment VI.

8 — (a) A comparison between the relative positions of the diaphragm and the ribs in this experiment and the relative positions of these anatomical parts in Experiment VI, shows that the diaphragm in its contraction reduces its vertical and lateral expansion; and while so doing descends through its normal range of downward movement after ordinary expiration.

(b) This downward descent of the diaphragm is independent of the lowering of the ribs. This is proved by the stationary position of the tenth and twelfth ribs in spite of a considerable descent of the diaphragm.

9 — A visual comparison between the convexity of the two diaphragmatic domes and of the costal arches in this and in Experiment VI, clearly shows that the curves described by the domes are narrower in this than in Experiment VI, whereas the curves described by the arches are exactly as wide in this as in the other experiment.

EXPERIMENT IX

OBJECTS OF THE EXPERIMENT :—

One of the objects of the experiment was to record the relative positions of the diaphragm and the ribs after normal inspiration. Another object was to ascertain the normal ranges of the upward and downward movements of both the diaphragm and the ribs, during the normal act of respiration in the case of the subject exposed to X-Ray in the six experiments published in this number. The third object was to record the relative positions of the ribs and the diaphragm after normal inspiration, with a view to compare these with the relative positions of the diaphragm and the ribs after lowering the diaphragm through its downward normal range at the end of normal expiration without moving the ribs, as is done in the last experiment.

PREPARATION OF THE SUBJECT :—

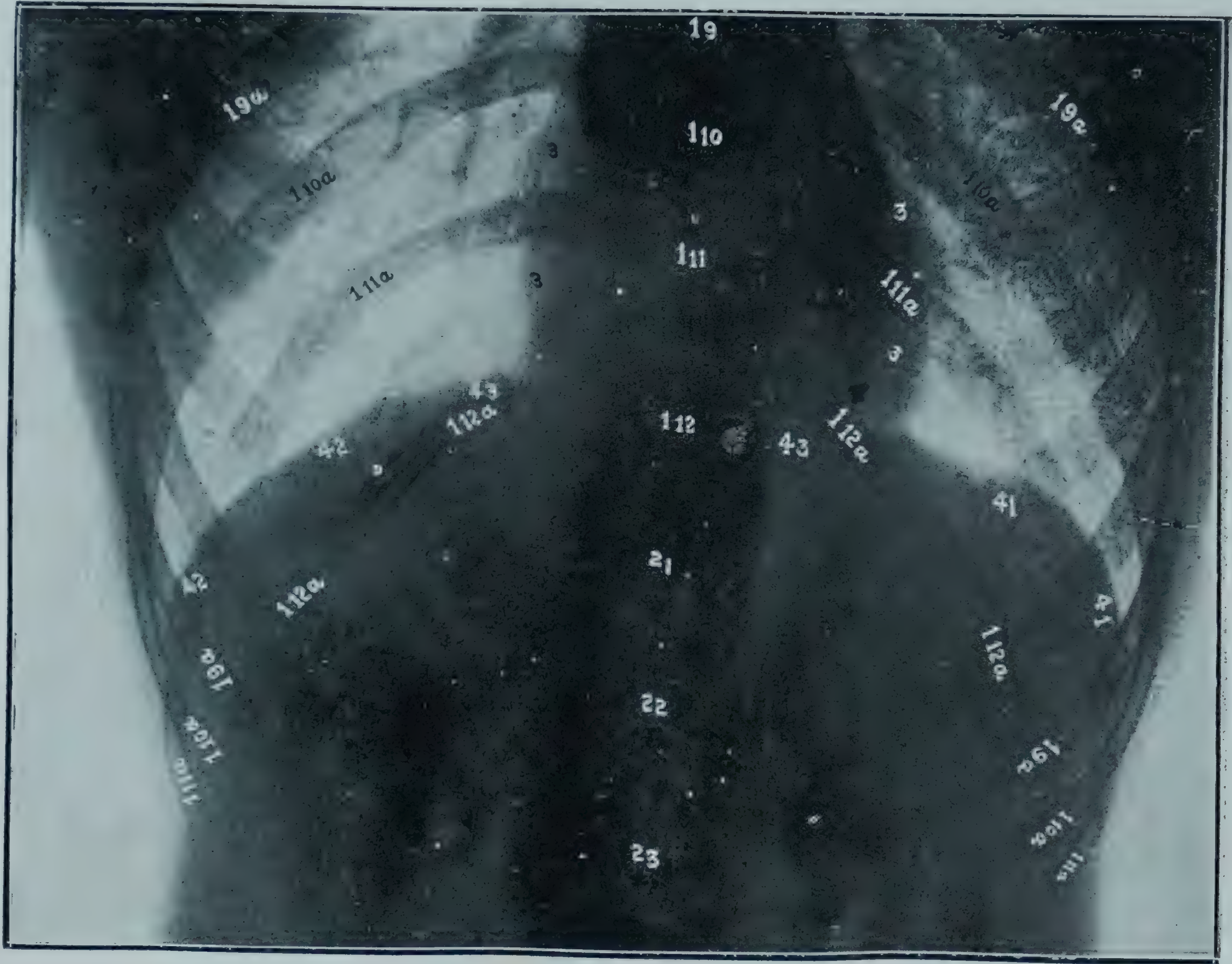
The same subject as in the last was immediately taken up for this experiment.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. The subject held his breath after a normal inspiration. The radiograph taken in this condition is produced in Fig. XLVIII. Fig. XLIX gives the line drawing of the same.

Fig. XLVIII

Radiograph XIII



Relative Positions of the Diaphragm and the Ribs
after
Ordinary Inspiration.

References to Radiograph XIII

1_9 The Ninth Dorsal.

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

REFERENCES TO RADIOGRAPH XIII

1_9 The Ninth Dorsal.

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

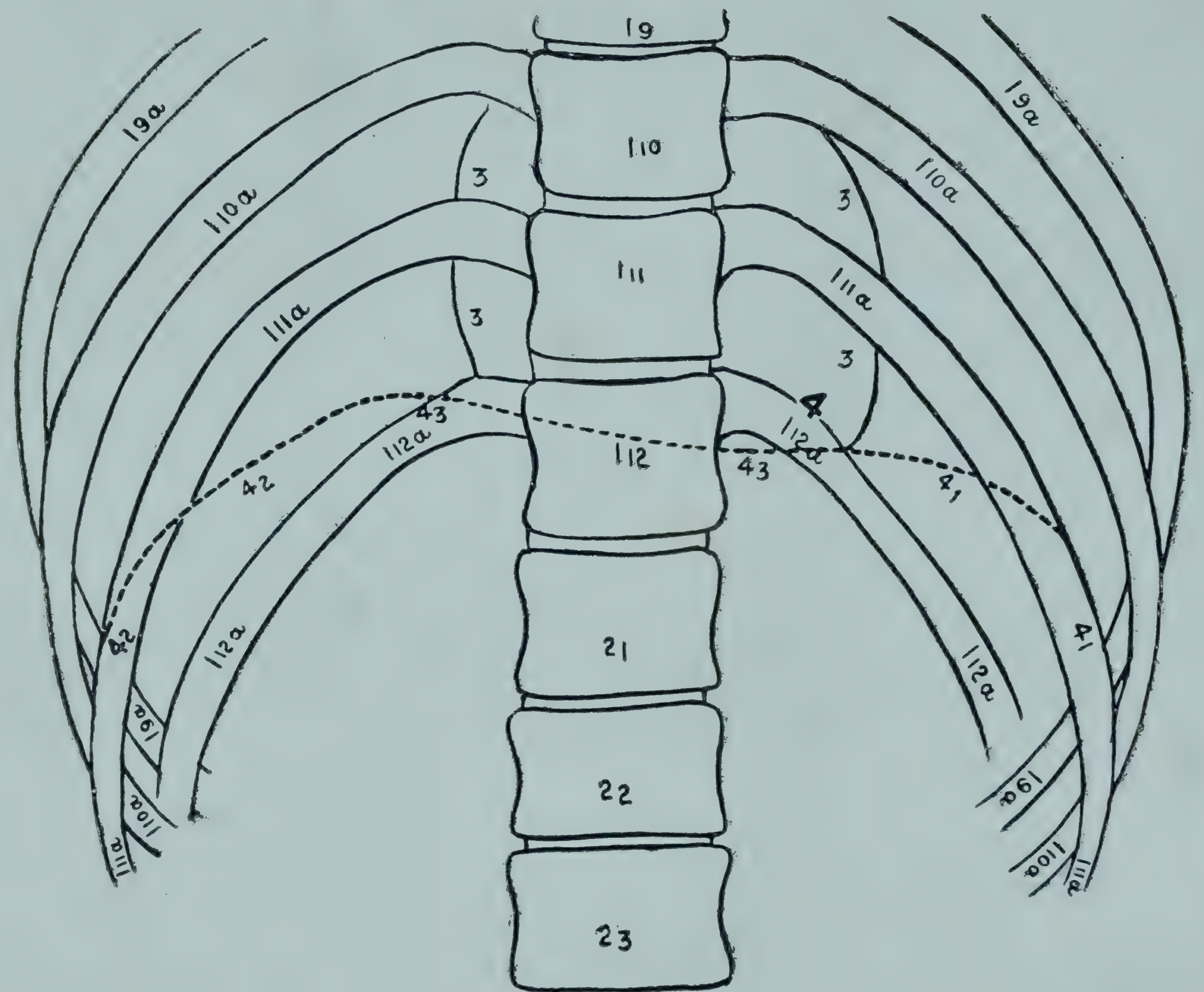
4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. XLIX



Line Drawing of *Radiograph XIII*

POINTS OF STUDY:—

[These points have been divided into two parts. Part 1 notices results of a comparison made between the present radiograph and Radiograph X. Part 2 contains points of comparison between the present radiograph and Radiograph XII.]

PART I

1 — (a) The radiograph as it is produced here covers the last four dorsal and the first three lumbar vertebræ.

(b) Both the dorsal and the lumbar parts of the spine are covered up by the shadows of the heart and the diaphragm.

(c) The ninth ribs are to be seen only in parts. The tenth, eleventh and twelfth ribs are visible in their entirety.

(d) The heart is to be seen almost the whole of it excepting the uppermost portion which is left out of this picture.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome stands a little below the level of the upper border of the twelfth dorsal. In Experiment VI this dome stood a little higher than the level of the lower border of the eleventh dorsal. This shows that in normal inspiration the right dome of the diaphragm lowers down only but slightly. In the case of the present subject the downward range of the diaphragm may be measured by the breadth of the root of the twelfth right rib. A visual examination of Radiographs X and XIII will show that in Radiograph X the right dome covers the root of the twelfth rib, whereas in Radiograph XIII the right dome is lowered so as to leave the root of the twelfth rib clearly above it.

(c) The shadows of the right half of the diaphragm stretch just up to the outer border of the lowest part

of the eleventh rib. In Experiment VI these shadows stretch far beyond the eleventh right rib and even slightly cover a part of the tenth rib. Thus it can be clearly seen that during inspiration the lateral expansion of the right half of the diaphragm has decreased. A visual examination would indicate that the shrinkage in the lateral expansion is nearly the same as in vertical expansion, that means the shrinkage all over the right half of the diaphragm is nearly uniform.

3 — (a) The left dome stands in level with the middle of the twelfth dorsal. In Radiograph X this dome stood slightly below the level of the upper border of the twelfth dorsal. A comparison between these two levels of the left dome shows that in inspiration the left dome has descended through the length of the upper half of the twelfth dorsal; or in terms of the breadth of the root of the twelfth rib the left dome has descended exactly through as much space as is covered by this root. As shown in 2 — (b) *supra*, the right dome had descended only as much as the left dome is found to have done now. That means the descent of both the right and the left domes has been proportionate.

(b) The shadows of the left half of the diaphragm extend to the outer border of the eleventh left rib. In Radiograph X these shadows stretch beyond the eleventh rib so as to touch the inner border of the tenth. This indicates a shrinkage in the lateral expansion of the left half of the diaphragm during inspiration. A visual examination of Radiographs X and XIII will indicate that the vertical shrinkage of the left half of the diaphragm is nearly the same as the lateral shrinkage of it. It will further indicate that in sinking down during inspiration the right and left domes of the diaphragm have descended almost parallel to themselves.

4 — (a) The central tendon lies across the lower half of the twelfth dorsal. In Radiograph X this tendon lay across the upper half of the twelfth dorsal. A comparison between these two positions of the central tendon shows that during inspiration it has fallen through the height of the upper half on the twelfth dorsal. When we note the vertical fall of the right and left domes along with that of the central tendon, we find that the whole curvature of the diaphragm has descended parallel to itself during inspiration: A result thoroughly corroborating the findings of modern anatomists.

(b) Although in the present radiograph the shadows of the central tendon are mixed up with those of the heart, the spine and the ribs, they can be sufficiently distinguished to enable us to determine their position.

5 — The distance between the two upper corners of the first lumbar vertebra is 4.5 cm. In the last three experiments this distance was recorded to be the same. Hence it will be seen that the distances between the plate and the subject on the one hand and the subject and the tube on the other, were the same in this as in the last three experiments. It is to be noted that the same subject was exposed to X-Ray in this experiment as in the last three.

6 — The distance between the inner borders of the ninth ribs measured across the upper border of the first lumbar, is 24.7 cm. A similar distance between the tenth ribs is 23.5 cm. In Radiograph X these distances were respectively 23.7 and 22.5 cm. These figures when compared show that in ordinary inspiration the ribs are raised, the ninth and the tenth ribs being so elevated that the distance between their inner borders is increased by 1 cm. Even to the eye the costal arches in the present experiment present curves that

are wider than the respective costal curves of Experiment VI.

7 — A careful examination of the movements of the diaphragm and the ribs during normal respiration, Experiment VI showing conditions available at the end of ordinary expiration, and the present experiment showing conditions available at the end of ordinary inspiration, shows that the respiratory movements of the diaphragm and the ribs are within a very small range. The lateral capacity of the thorax at the level of the ninth and tenth ribs, is increased only by 1 cm. The vertical capacity of the thorax as far as it can be measured by the descent of the diaphragm is also increased only by the breadth of the roots of the twelfth ribs.

PART II

1 — Portions of the spine, the ribs, the heart and the diaphragm, covered by this radiograph have been studied in the first part. Vide 1 — (a), (b), (c), (d), *supra*.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome stands a little below the level of the upper border of the twelfth dorsal. In Experiment VIII this dome stood a little higher than the lower margin of the twelfth dorsal. That means in the last experiment the right dome stands lower than in the present experiment by nearly one-third of the length of the twelfth dorsal.

(c) The shadows of the right half of the diaphragm stretch just up to the outer border of the lowest part of the eleventh rib. In the last experiment these shadows stretched only as far as the outer border of the twelfth rib. This shows that the lateral expansion of the right half of the diaphragm is much less in the last experiment than in the present. A visual examination of

the shadows of the right dome in the present and the last radiographs will clearly show that there is an all round shrinkage in the expansion of the right dome on a larger scale in the previous experiment than in the present, the curve of the right dome being narrower in the last experiment than in the experiment under study.

3 — (a) The left dome stands in level with the middle of the twelfth dorsal. In Experiment VIII this dome stood in level below the upper border of the first lumbar. These two positions of the left dome clearly show that this dome sank much lower in the last experiment than in the present, the difference being indicated by more than half the length of the twelfth dorsal.

(b) The shadows of the left half of the diaphragm extend to the outer border of the eleventh left rib. In the last experiment these shadows extended slightly beyond the twelfth left rib. This shows that the lateral expansion of the left half of the diaphragm was much smaller in the previous experiment than in the present. A visual examination of the shadows of the left half of the diaphragm in this and in the last radiograph, will clearly indicate that the shrinkage in the vertical as well as in the lateral expansions of the left half is greater in the last experiment than in the present, the diaphragmatic curve of the left half being far narrower in the previous experiment than in the experiment under examination.

4 — (a) The central tendon lies across the lower half of the twelfth dorsal. In the previous experiment this central tendon lay nearly in this very position, so far as its right side was concerned. As for the left side, the central tendon stood a little below in the last experiment than in the present. Broadly speaking it may be observed that the positions of the central tendon remain almost unaltered in the two experiments, this and the last.

(b) The fact that the diaphragm stands a little higher in this experiment than in the last, can be varified by the mixing up of the shadows of the heart and the diaphragm, where the two meet in front of the twelfth dorsal. In the last radiograph the shadows of the heart and the diaphragm stand almost separate.

5 — Taking into consideration all the three parts of the diaphragm, the two domes and the central tendon, we find on a comparison of this and the previous radiograph, that this roof of the abdomen has been lowered down as a whole much more in Experiment VIII than in Experiment IX. The lowering of the diaphragm in Experiment VIII as well as in Experiment IX started after normal expiration. In Experiment VIII the diaphragm was lowered by contracting it, without raising the ribs. In Experiment IX again the diaphragm was similarly contracted but simultaneously the ribs were raised. So the difference between the last and the present experiment lies in the movement of the ribs, but not in the movement of the diaphragm which is made to contract after ordinary expiration. Naturally in both the experiments, this and the last, the diaphragm descends through its normal downward range, in the last experiment it being only made to descend forcibly below its normal limit of descent, by a more complete contraction of its muscular fibres.

6 — The distance between the outer borders of the ninth, tenth, eleventh and twelfth ribs in the present radiograph and in the last, is as tabulated below.

No. of the ribs	Distance in cm. in Radiograph XII	Distance in cm. in Radiograph XIII
9	25.0	26.0
10	24.5	25.0
11	20.5	20.8
12	13.8	14.0

A glance at this table will show that the ribs stand wider apart in the present experiment than in Experiment VIII, the higher the rib the wider it stands, so far as the last four ribs are concerned. A visual examination of the arches of the ribs in Radiographs XII and XIII, shows that the costal arches describe wider curves in Radiograph XIII than the corresponding curves in Radiograph XII. The larger distances between the different sets of ribs in the present experiment are due to the fact that the ribs are raised from the position they occupied at the end of normal expiration; but in the last experiment they were not made to move at all.

7 — As noted in point 5, part one above, the distances between the plate and the subject on the one hand and the subject and the tube on the other were the same in this as in the last three experiments, the same subject being exposed to X-Ray every time.

8 — Taking into account the results of Experiments VI, VIII and IX, we find that after expiration the diaphragm may be contracted and lowered through its normal downward range either with raising the ribs or without it. We also find that the diaphragm can be contracted and lowered beyond its normal downward range, here again the feat being accomplished without moving the ribs.

EXPERIMENT X

OBJECTS OF THE EXPERIMENT :—

One of the objects of the experiment was to note the relative positions of the diaphragm and the ribs when the latter were raised beyond their upward normal range after ordinary inspiration. The other object was to institute a comparison between these relative positions of the diaphragm and the ribs and the positions they occupied in the last experiment.

PREPARATION OF THE SUBJECT :—

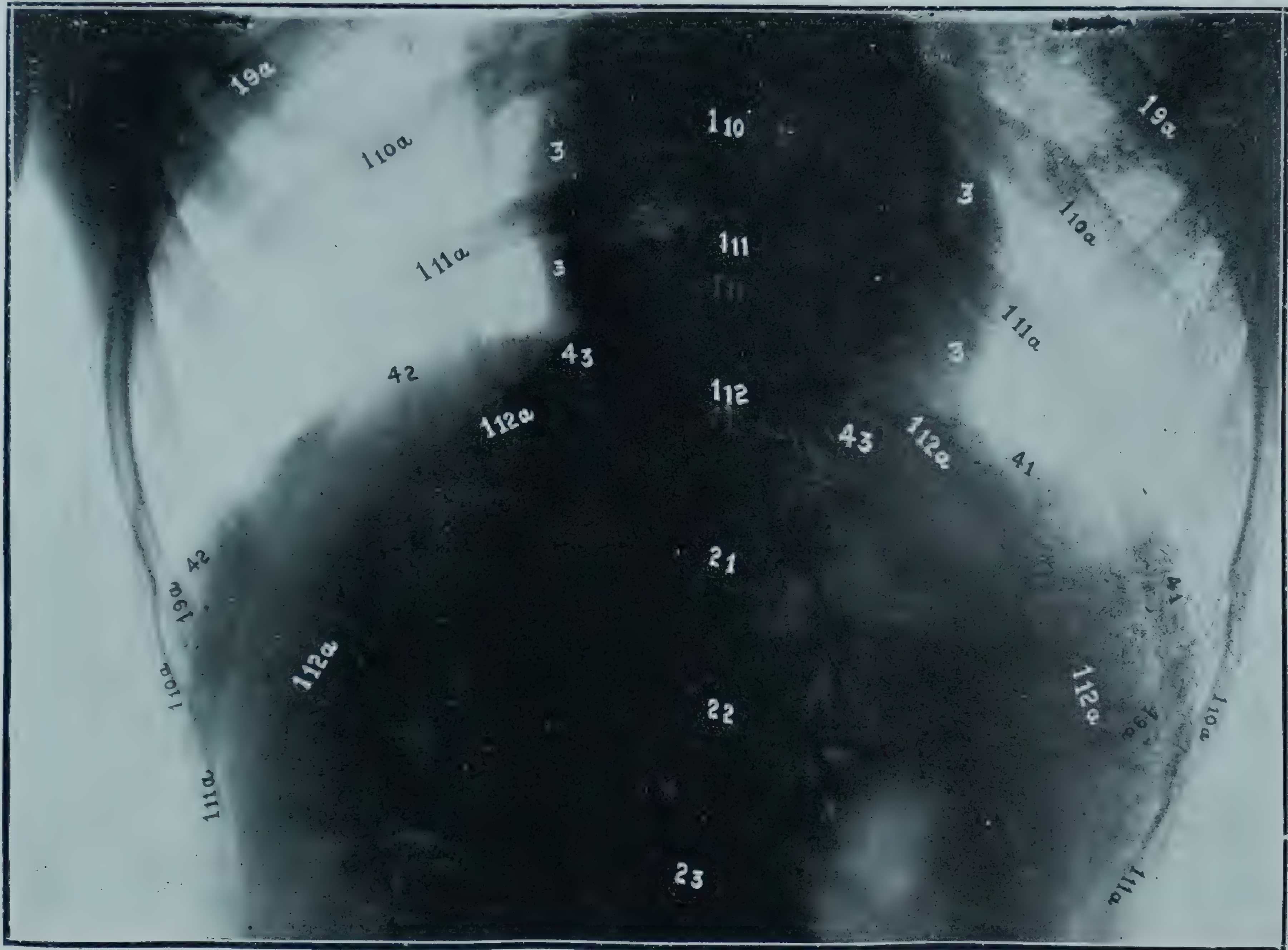
The same subject as in the last experiment was immediately taken up for this.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. After a normal inspiration the subject was made to hold his breath and raise his ribs. The radiograph taken while this upward position of the ribs was being maintained is produced in Fig. L. Fig. LI gives the line drawing of the same.

Fig. L

Radiograph XIV



Relative Positions of the Diaphragm and the Ribs

when

The Ribs are Raised beyond their Upward Normal Range

After Normal Inspiration.

References to Radiograph XIV

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4^3 The Central Tendon.

REFERENCES TO RADIOGRAPH XIV

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

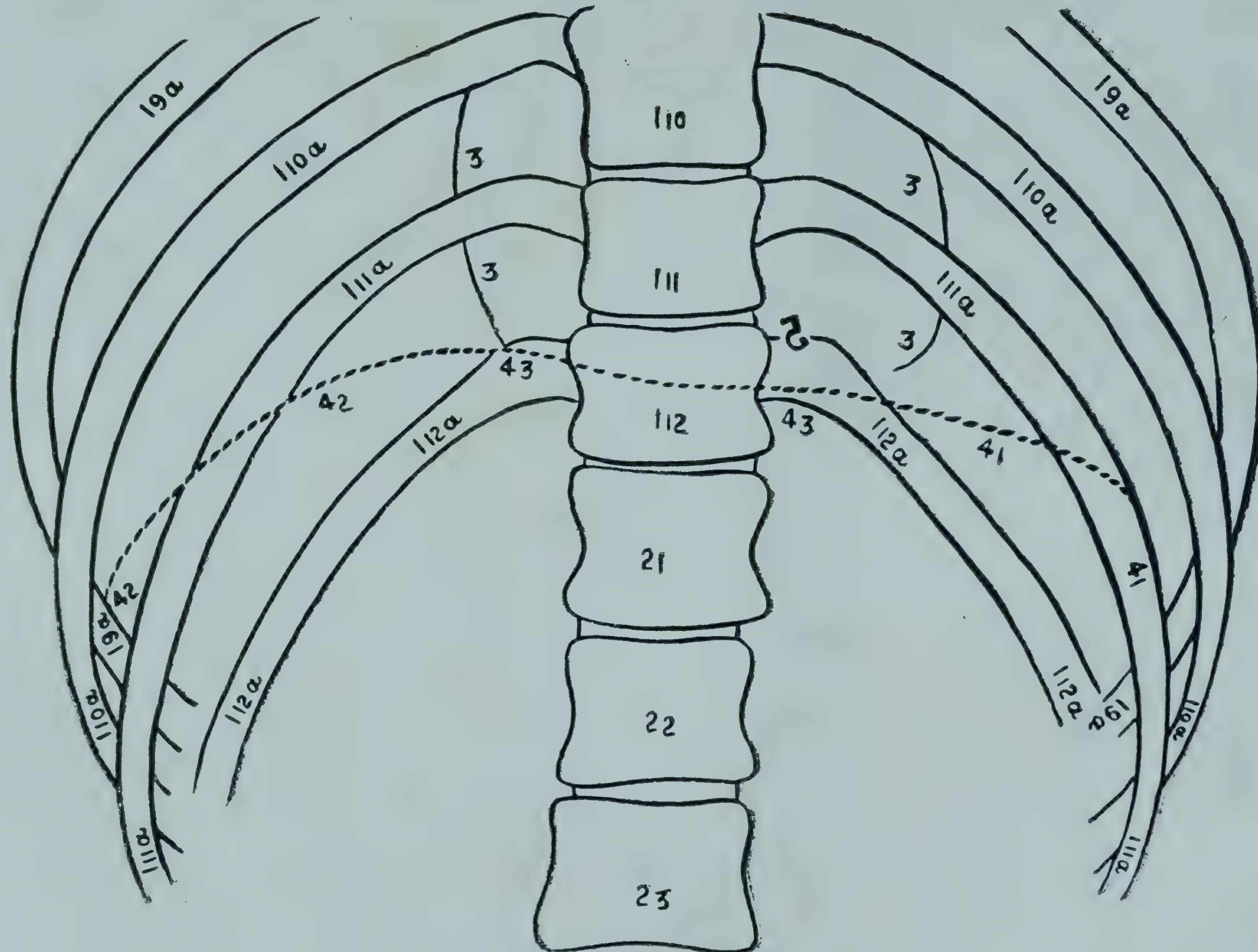
4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. LI



Line Drawing of *Radiograph XIV*

POINTS OF STUDY :—

1 — (a) The radiograph as it is produced here covers the last three dorsal and the first three lumbar vertebræ.

(b) Both the dorsal and the lumbar parts of the spine are covered up by the shadows of the heart and the diaphragm.

(c) The ninth ribs are to be seen only in parts. The tenth, eleventh and twelfth ribs are visible in their entirety.

(d) The heart is to be seen almost the whole of it, excepting the uppermost portion which is left out of this picture.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome stands in level with the upper margin of the twelfth dorsal. In Experiment IX this dome stood a little below this level. That means in this experiment the right dome has risen vertically although the rise is very small.

(c) The shadows of the right half of the diaphragm not only cover the lower part of the eleventh right rib, but they also touch the inner border of the tenth. In Experiment IX these shadows extended just up to the outer border of the lowest part of the eleventh rib. That means the lateral expansion of the right half of the diaphragm is larger in the present experiment than in the last. In (b) of this section it has been shown that there is a slight vertical rise of this dome in the present experiment. So it is clear that the right half of the diaphragm has in this experiment undergone vertical as well as lateral expansion.

3 — (a) The left dome stands in level with the middle of the twelfth dorsal. In the last experiment this dome stood just at this level. So we find that the vertical position

of the left dome has not undergone any change in the experiment under consideration.

(b) The shadows of the left half of the diaphragm extend as far as the outer border of the eleventh left rib. In the previous experiment these shadows extended only thus far and not further. Thus it is clear that the lateral expansion of the left half of the diaphragm has not undergone any change in the present experiment, in relation with the position of the eleventh rib. Taking into account the results noted in the preceeding paragraph and in the present, we would have found that the left half of the diaphragm has neither risen vertically nor broadened laterally, its position being the same as in the previous experiment. But as we will notice below the eleventh left rib has not remained stationary. It has moved away from the spine. Hence we can conclude that the left half of the diaphragm has undergone a slightly larger vertical expansion in the experiment under discussion.

4 — (a) The central tendon lies across the upper half of the twelfth dorsal. In Experiment IX this tendon lay across the lower half of the same vertebra. Thus we find that in the present experiment the central tendon has risen higher by half the height of the twelfth dorsal. Putting together the results noted in 2, 3 and 4 we arrive at the conclusion that the diaphragm as a whole has risen vertically and also has undergone lateral expansion in the experiment under consideration.

(b) Although in the present radiograph the shadows of the central tendon are mixed up with those of the heart, the spine and the ribs, they can be sufficiently distinguished to enable us to determine their position.

5 — The distance between the two upper corners of the first lumbar vertebra is 4.5 cm. In the last four ex-

periments this distance was recorded to be the same. Hence it will be seen that the distances between the plate and the subject on the one hand and the subject and the tube on the other, were the same in this as in the last four experiments. It is to be noted that the same subject was exposed to X-Ray in this experiment as in the last four.

6 — The distance between the outer borders of the ninth, tenth, eleventh and twelfth ribs in the present radiograph and in the last is as tabulated below.

No. of the ribs	Distance in cm. in Radiograph XIII	Distance in cm. in Radiograph XIV
	26.0	26.5
10	25.0	25.4
11	20.8	21.0
12	14.0	14.0

A glance at this table will show that the ribs stand wider apart in the present experiment than in Experiment IX, the higher the rib the wider it stands so far as ninth, tenth and eleventh ribs are concerned. The twelfth ribs do not move from their place. A visual examination of the arches of the ribs in Radiographs XIII and XIV, shows that the costal arches describe wider curves in Radiograph XIV than the corresponding curves in Radiograph XIII. The larger distances between the different sets of ribs in the present experiment are due to the fact that the ribs are raised from the position they occupied in the last experiment that is at the end of normal inspiration.

7 — A careful examination of the relative positions of the diaphragm and the ribs in this experiment and in the last, shows that the ribs have risen higher in the present experiment and along with them the diaphragm, the latter having also undergone some lateral expansion.

EXPERIMENT XI

OBJECTS OF THE EXPERIMENT :—

At the end of normal inspiration, the ribs are raised through their ordinary upward range. One of the objects of the present experiment was to note the relative positions of the diaphragm and the ribs, when the latter were lowered through their downward normal range, after ordinary inspiration. The other object was to institute a comparison between the relative positions of the diaphragm and the ribs recorded in this experiment and their positions recorded in Experiment IX, that is, positions assumed at the end of ordinary inspiration.

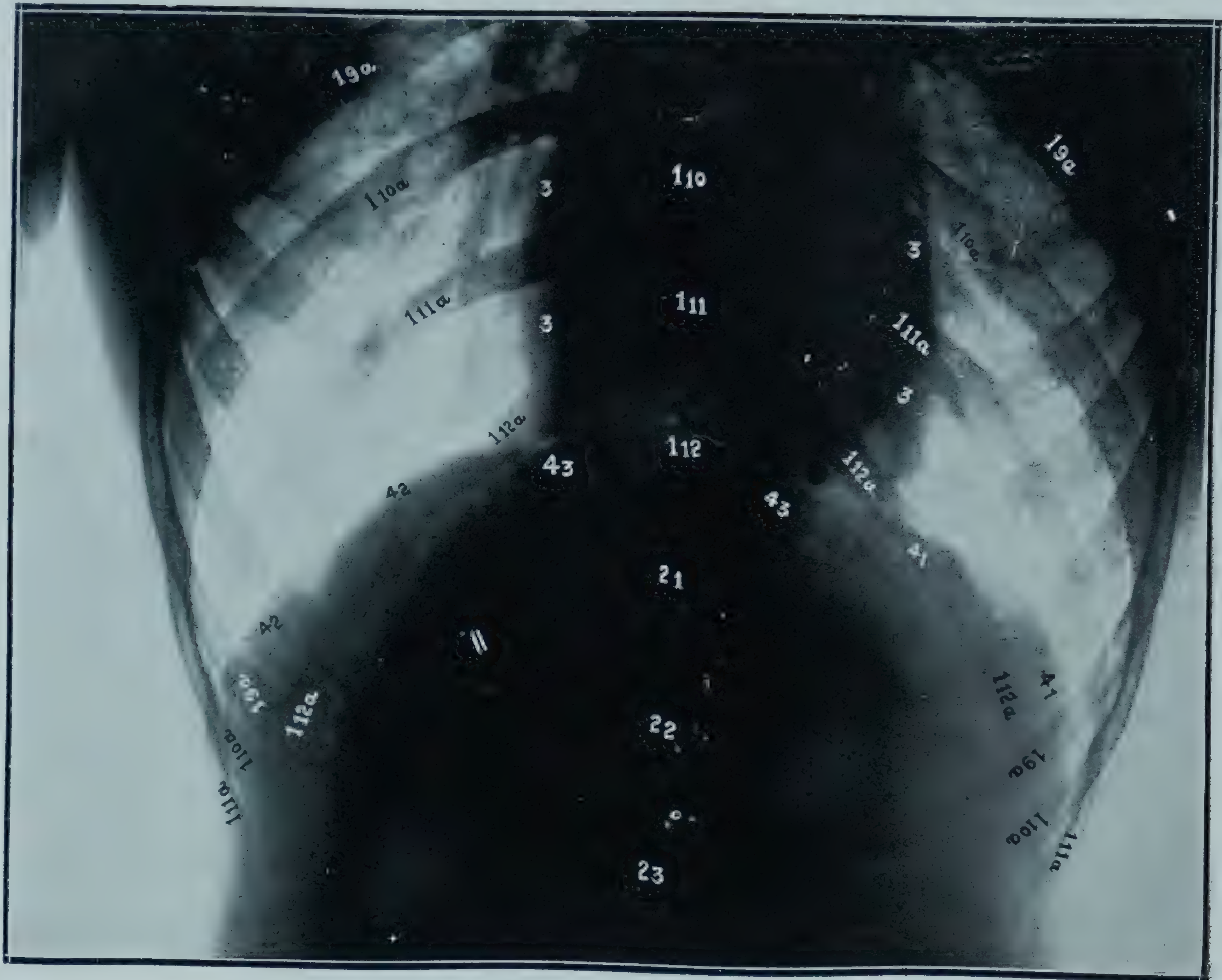
PREPARATION OF THE SUBJECT :—

The same subject as in the last was immediately taken up for this experiment.

THE EXPERIMENT PROPER :—

The positions of the tube, the subject and the plate continued to be the same as in the previous experiment. The subject held his breath after normal inspiration; and lowered his ribs through their ordinary downward range. The radiograph taken in this condition is produced in Fig. LII. Fig. LIII gives the line drawing of the same.

Fig. LII *Radiograph XV*



Relative Positions of the Diaphragm and the Ribs
when
The Ribs are Lowered through their Downward Normal Range.

References to Radiograph XV

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

References to Radiograph XV

1_{9a} The Ninth Ribs.

1_{10} The Tenth Dorsal.

1_{10a} The Tenth Ribs.

1_{11} The Eleventh Dorsal.

1_{11a} The Eleventh Ribs.

1_{12} The Twelfth Dorsal.

1_{12a} The Twelfth Ribs.

2_1, 2_2, 2_3 The Successive Lumbar Vertebræ up to the Third.

3 The Heart.

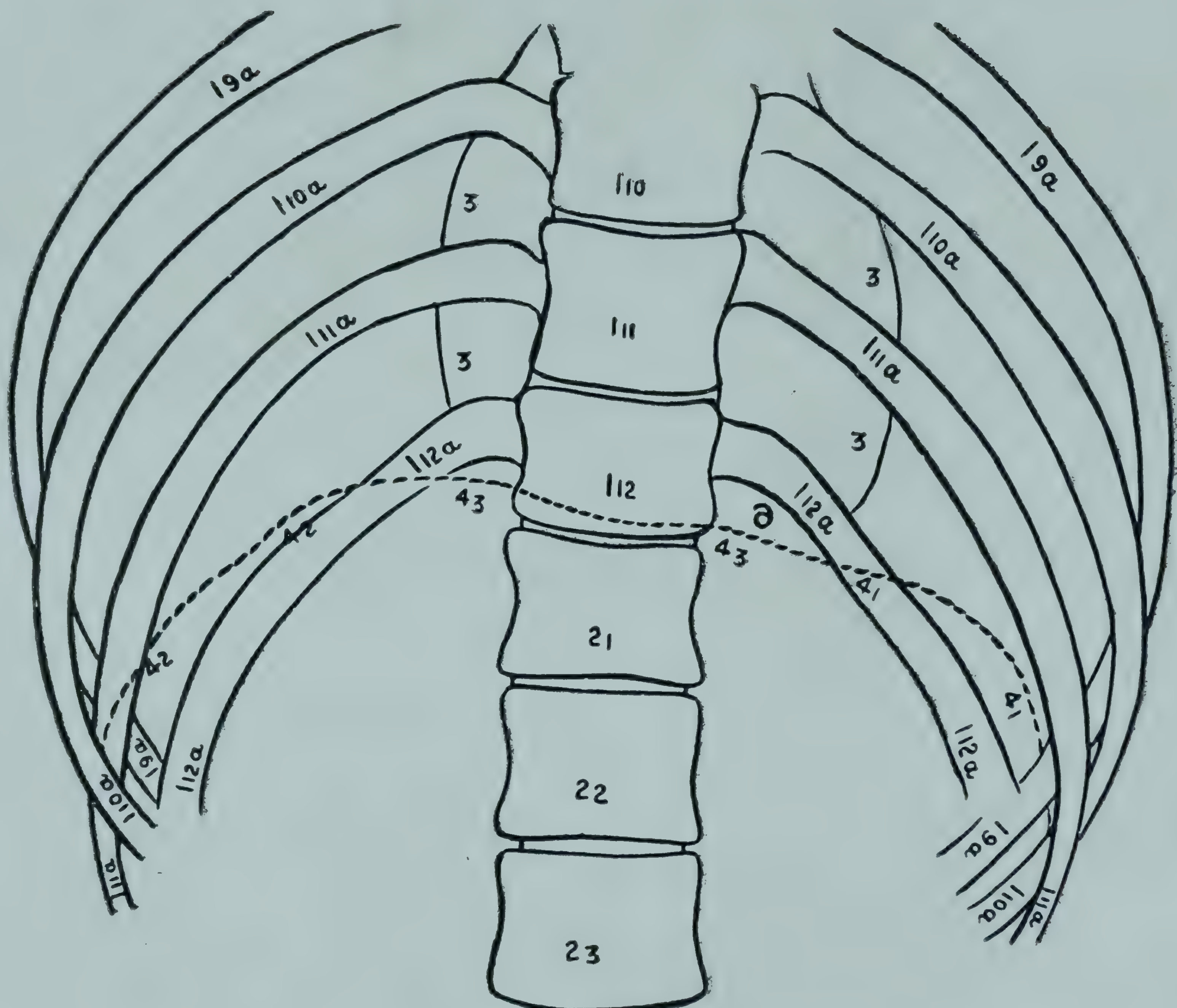
4_1 The Upper Margin of the Left Dome of the Diaphragm.

4_2 The Upper Margin of the Right Dome of the Diaphragm.

4_3 The Central Tendon.

N. B.—The thick dotted line indicates the diaphragm in the accompanying figure.

Fig. LIII



Line Drawing of *Radiograph XV*

POINTS OF STUDY :—

1 — (a) The Radiograph as it is produced here covers the last three dorsal and the first three lumbar vertebræ.

(b) Both the dorsal and the lumbar parts of the spine are covered up by the shadows of the heart and the diaphragm.

(c) The ninth ribs are to be seen only in parts. The tenth, eleventh and twelfth ribs are visible in their entirety.

(d) The heart is to be seen almost the whole of it, excepting the uppermost portion which is left out of this picture.

2 — (a) The upper border of the diaphragm can be clearly seen.

(b) The right dome stands a little below the level of the middle of the twelfth dorsal. In Experiment IX this dome stood a little below the level of the upper border of the twelfth dorsal. This shows that in this experiment the right dome of the diaphragm has been lowered down through the full height of the upper half of the twelfth dorsal.

(c) The shadows of the right half of the diaphragm very slightly encroach upon the lowest part of the eleventh left rib. In Experiment IX these shadows covered the eleventh left rib to a considerably larger extent. This means that the lateral expansion of the right half of the diaphragm has suffered some shrinkage in this experiment in comparison with Experiment IX. Although it has to be admitted that shrinkage in the lateral expansion is less pronounced than in the vertical expansion of the right half of the diaphragm, it is clear that this half in the present experiment has suffered in dimensions available to it in Experiment IX.

3 — (a) The left dome stands in level with the upper border of the first lumbar. In Experiment IX this dome

stood in level with the middle of the twelfth dorsal. A comparison between these two levels assumed by the left dome shows that this part of the diaphragm stands lower in the present experiment by the full height of the lower half of the twelfth dorsal than in Experiment IX.

(b) The shadows of the left half of the diaphragm lie clear of the eleventh left rib. In Experiment IX these shadows extended to the outer border of this rib. That means that there is considerable shrinkage in the lateral expansion of the left half of the diaphragm. Thus from the previous paragraph and the present we find that the left half of the diaphragm has suffered greatly in expansions both vertical and lateral, in going from Experiment IX to Experiment XI.

4 — (a) The central tendon lies across the lowest one-fourth of the twelfth dorsal. In Experiment IX this tendon lay across the lower half of the twelfth dorsal. A comparison between these two positions of the central tendon shows that it has descended by one-fourth of the height of the twelfth dorsal in this experiment from its position in Experiment IX. When we note the vertical fall of the right and left domes along with that of the central tendon, we find that the whole curvature of the diaphragm stands lower in this experiment than in Experiment IX, although the descent of the central tendon is less pronounced than that of the two domes.

(b) Even though in the present radiograph the shadows of the central tendon are mixed up with those of the heart, the spine and the ribs, they can be sufficiently distinguished to enable us to determine their position.

5 — The distance between the two corners of the first lumbar vertebra is 4 5 cm. In the last five experiments this distance was recorded to be the same.

Hence it will be seen that the distances between the plate and the subject on the one hand and the subject and the tube on the other, were the same in this as in the last five experiments. It is to be noted that the same subject was exposed to X-Ray in this experiment as in the last five.

6 — The distance between the outer borders of the ninth, tenth, eleventh and twelfth ribs in the present radiograph and in Radiograph XIII, is as tabulated below.

No. of the ribs	Distance in cm. in Radiograph XIII	Distance in cm. in Radiograph XV
9	26.0	25.1
10	25.0	24.2
11	20.8	20.1
12	14.0	13.0

An examination of this table will show that the ribs are lowered down in this experiment from their position in Experiment IX, the higher the rib the lower it has descended, so far as the ninth, tenth and eleventh ribs are concerned. A visual examination of the arches of the ribs in Radiographs XIII and XV, shows that the costal arches describe narrower curves in the present radiograph than in Radiograph XIII. This is because the ribs are intentionally lowered down. What we have to observe is that the lowering of the ribs is attended by the lowering of the diaphragm also.

7 — A visual examination of the present radiograph shows that the diaphragm in its contraction draws away from the heart. Because we find the shadows of these two anatomical parts standing almost separately, though marching together across the spine.

THE DIAPHRAGM AND THE RIBS

PART I

Can We Raise One Without Lowering the Other ?

(Concluded)[1]

Thus far we have proved that we can raise the diaphragm without lowering the ribs and also that we can raise the ribs without lowering the diaphragm. Not only this but we have also proved that we can raise either the diaphragm or the ribs not only without lowering the other, but in spite of the other being also raised. The evidence adduced consisted of a few X-Ray experiments that we had already performed in connection with other pieces of research work and also of some experiments on intra-gastric pressure conducted especially to understand the question under discussion. After the publication of this portion of the present article, we undertook several X-Ray and other experiments in order to find additional evidence in support of our theory. Out of these, five experiments appeared in the second issue of this volume and the remaining are published in the Scientific Section of this number. We shall now proceed to see how this additional evidence fully corroborates the conclusions reached in the portion of this article already published.

Let us take Experiments I and II. Experiment I was performed to record the positions of the diaphragm and the ribs after a forcible deep expiration. Experiment II was done for recording the positions of these two organs during Uḍḍiyāna. Radiographs V and VI faithfully represent the positions of the diaphragm and the ribs assumed by these during the two experiments respectively.

Now let us compare the positions of the diaphragm in these radiographs. As pointed out on pp. 97 and 98 of this volume in

1 The first portion of this article has appeared in Vol. III, No. 1.

sections 2, 3 and 4, both the left and the right domes of the diaphragm stand much higher in Radiograph VI than in Radiograph V. Similarly the central tendon has also risen higher though not to the same extent as the two domes. That means in going from deep forcible expiration to Uḍḍiyāna the diaphragm has been raised. Now we want to see whether this rise of the diaphragm is due to the lowering of the ribs. For this we have to compare the positions of the ribs in the two experiments referred to above. In Experiment I the distance between the tenth ribs at the level[1] of the upper border of the first lumbar is 23.2 cm. In Experiment II this distance is increased to 26.5 cm. Thus there is an increase of 33 mm. which clearly demonstrates a considerable rise of the tenth ribs in Uḍḍiyāna. Sections 5 and 6 on p. 99 of this volume, point out that other ribs are also elevated in going to Uḍḍiyāna from deep forcible expiration. So we find that in Experiment II the diaphragm has been raised from the position it occupied in Experiment I, and that this rise has been effected not by lowering the ribs, but in spite of the ribs being raised also.

Again these very experiments prove that the ribs can be raised not only without lowering the diaphragm but in spite of its being raised simultaneously.

Thus we find that the evidence drawn from Experiments I and II corroborates the conclusion we had reached previously, namely, that the diaphragm can be raised independently of the lowering of the ribs and that the ribs can be raised independently of the lowering of the diaphragm. (Vide p. 37)

Again this independence of action of the diaphragm and the ribs can be proved by the fact that both of them can be lowered simultaneously.

This fact is borne out by Experiments II and III given in the last issue. Experiment II was done with Uḍḍiyāna and Experi-

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1 This particular level has been selected for comparison because at this level the distances between the tube and the subject, and also between the subject and the plate, were relatively the same in both the experiments under examination. In consequence of this circumstance a comparison between measurements taken at this level would yield correct results.

ment III with Nauli-Madhyama. Radiographs VI and VII represent the positions occupied by the diaphragm and the ribs in Uḍḍiyāna and Nauli-Madhyama respectively. An examination of the ribs included in Radiographs VI and VII, shows that the ribs are lowered in passing from Uḍḍiyāna to Nauli-Madhyama. (Vide sections 5 and 6 on pp. 104 and 105 of this volume.) Again an examination of the positions of the diaphragm in the same radiographs indicates that this organ also stands lower in Nauli-Madhyama than in Uḍḍiyāna. (Vide sections 2, 3 and 4 on pp. 103 and 104 of this volume.) Thus we find that both the diaphragm and the ribs can be lowered simultaneously. Hence the lowering of the diaphragm is independent of the raising of the ribs and the lowering of the ribs is independent of the raising of the diaphragm.

Putting together Experiments I, II and III, we conclude that the diaphragm can be raised without lowering the ribs and also it can be lowered without raising the ribs. In fact the rise and fall of the diaphragm is independent of the movements of the ribs. Another conclusion is that the ribs can be raised or lowered without the help of the diaphragmatic movements.

It may be urged with some show of truth, however, that the actions studied in Experiments I, II and III are *abnormal*; and hence the findings would not hold good in the case of normal actions. For instance the very first experiment was performed with *forcible* deep expiration. Again both the second and third experiments were done while this *forcible* deep expiration was being maintained. Hence it follows that the positions of the diaphragm and the ribs as recorded in all these experiments, are outside their normal range of action.

In order to obviate this difficulty in the way of the conclusions based on the first three experiments being accepted as sound, we performed several other experiments which have been given in the Scientific Section of this issue. Therein we have studied both the diaphragm and the ribs while they moved within their *normal* range.

Four ranges may be marked out in this connection as normal. The diaphragm has two normal ranges within which it moves, one upward and the other downward. The ribs also have two normal ranges within which they move, one upward and the other downward. The diaphragm moves through its upward normal range when it begins to rise after normal inspiration and keeps on rising during normal expiration. Again it moves through its downward normal range when it begins to sink after normal expiration and keeps on sinking during normal inspiration. The ribs move through their upward normal range when they begin to rise after normal expiration and keep on rising during normal inspiration. Again they move through their downward normal range when they begin to sink after normal inspiration and keep on sinking during normal expiration.

Having mapped out four normal ranges, two for the diaphragm and two for the ribs, we now want to see whether within these normal ranges either the diaphragm or the ribs have to depend upon the other for their upward and downward movements.

Let us start with the ribs. In Experiment VI we find the ribs standing at the bottom of their normal downward range because the position recorded here is one occupied by the ribs at the end of normal expiration. Radiograph X represents this position. Now the ribs are raised through their upward normal range till they stood at the top of it. That position is recorded in Radiograph XI taken during Experiment VII. A comparison between the Radiographs X and XI clearly shows that the rise in the position of the ribs in Experiment VII has been considerable. For instance in Experiment VI the distance between the inner borders of the tenth ribs across the upper margin of the first lumbar[1] is 22.5 cm. In Experiment VII this distanee is 27.6 cm. It means that the tenth ribs have been so elevated in Experiment VII, that the increase in the lateral capacity of the thorax across the first lumbar is 5.1 cm. (Vide section 8, p. 181 of this volume.) A similar rise has been observed in the case of other ribs also.

1 See foot-note on page 211.

Now we want to see (1) whether this rise of the ribs through their normal upward range has been effected, as the anatomists would have it, by the diaphragm acting from the central tendon which they think becomes the fixed point and which, according to them, acts on the fulcrum of the abdominal viscera. (2) And also whether the rising ribs have lowered the diaphragm as Mr. Muller would like to have it according to his theory.

Taking up the first question, and studying it in the light of the evidenee derived from Experiments VI and VII, we find that the diaphragm has not at all descended so as to act from the fulcrum of the abdominal viscera. On the contrary it has decidedly risen in its position, as is clear from the sections 2, 3, 4 and 5 on pp. 179 and 180 of this volume. Thus the present day anatomical theory that the ribs are raised by the descending diaphragm falls to the ground.

Against the conclusion arrived at in the last paragraph, it may be urged that the ribs were raised, indeed; but the diaphragm was not allowed to act as the glottis was tightly closed. Had the diaphragm been free to act, it would have been found lowered down. We do not think that this objection is valid. Because the question is not whether the ribs rise through their upward normal range *simultaneously* with the action of the diaphragm, but the question is whether the ribs rise through their upward normal range *because of* the action of the diaphragm. Had the ribs been rising because of the action of the diaphragm, the ribs would not have risen at all in Experiment VII, as the diaphragm was not allowed to act owing to the closure of the glottis. But as we find that the ribs have been actually raised without the action of the diaphragm, we cannot avoid the conclusion that the upward movement of the ribs is independent of the action of the diaphragm. Although we have mapped out four normal ranges, one upward and one downward for the ribs, and two similar ones for the diaphragm, our purpose was with the movements of the ribs through their upward normal range only. Because it was here that we differed from the anatomists of to-day. So far as the

remaining three ranges go, we have no disagreement with the medical scientists, and therefore we do not propose any examination of their views here.

Having thus examined the theory of the anatomists, we now scrutinize the theory of Mr. Muller. According to him the rising ribs must lower the diaphragm.

Now taking the same evidence, namely Experiments VI and VII, into account, we find that the ribs have been raised but the diaphragm has not been lowered. (Vide sections 2, 3, 4, 5 and 8 on pp. 179, to 181 of this volume.) Here again it may be urged, as it was urged against us when we were scanning the theory of the anatomists, that the diaphragm did not descend because the glottis was closed. Had it been open, the diaphragm should certainly have been lowered down.

Here again we find that this argument has no force, because Mr. Muller does not limit his statement to be true only under particular circumstances, such as the glottis being kept open. According to him whenever the ribs are raised, the diaphragm must be lowered down. And as we find from the X-Ray evidence adduced here, that the diaphragm is not lowered down even when the ribs are raised, we can reject his theory to be merely speculative and not founded upon any experimental evidence.

Further Mr. Muller maintains that "*it is quite impossible to move the diaphragm separately, intentionally or voluntarily*, (Italics ours), although, of course, we move it indirectly by moving the ribs or the abdominal muscles." We shall now proceed to examine the validity of this statement.

In this assertion of Mr. Muller, movements of three anatomical parts are concerned.

i The movements of the diaphragm.

ii The movements of the abdominal muscles.

iii The movements of the ribs.

Out of these the diaphragm and the abdominal muscles are muscles and the ribs are bones.

Now we will have to note a few physiological facts before we proceed further.

Muscles are of two types—*voluntary* and *involuntary*. We cannot move or get to work the involuntary muscles *intentionally*, but the voluntary muscles are under our control and we can move them or get them to work *voluntarily*. According to all authorities including Mr. Muller, the abdominal muscles are voluntary, that is, we can move them according to our choice. In the case of voluntary muscles, however, we are to remember one fact very carefully. When we talk of voluntary control over a muscle, it only means control over its contraction. Relaxation even in the case of voluntary muscles is only a passive act. So when we get a voluntary muscle to move or to work or to act, we only get it to contract under nerve stimulus. As soon as the stimulus is withdrawn the muscle relaxes *of itself*, that is, *passively*. The diaphragm also is a voluntary muscle according to the anatomists, but Mr. Muller differs from them and holds that the diaphragm is only an involuntary organ. That is why he says that it is impossible to move the diaphragm voluntarily. Now if the involuntary muscles are to be moved they have to be moved chemically[1] or mechanically. So Mr. Muller thinks that the diaphragm, if it is to be moved, must be moved by means of the ribs or the abdominal muscles. The third anatomical structure is the ribs. They are bones and as such incapable of moving themselves. According to Mr. Muller they are moved by the intercostals etc.

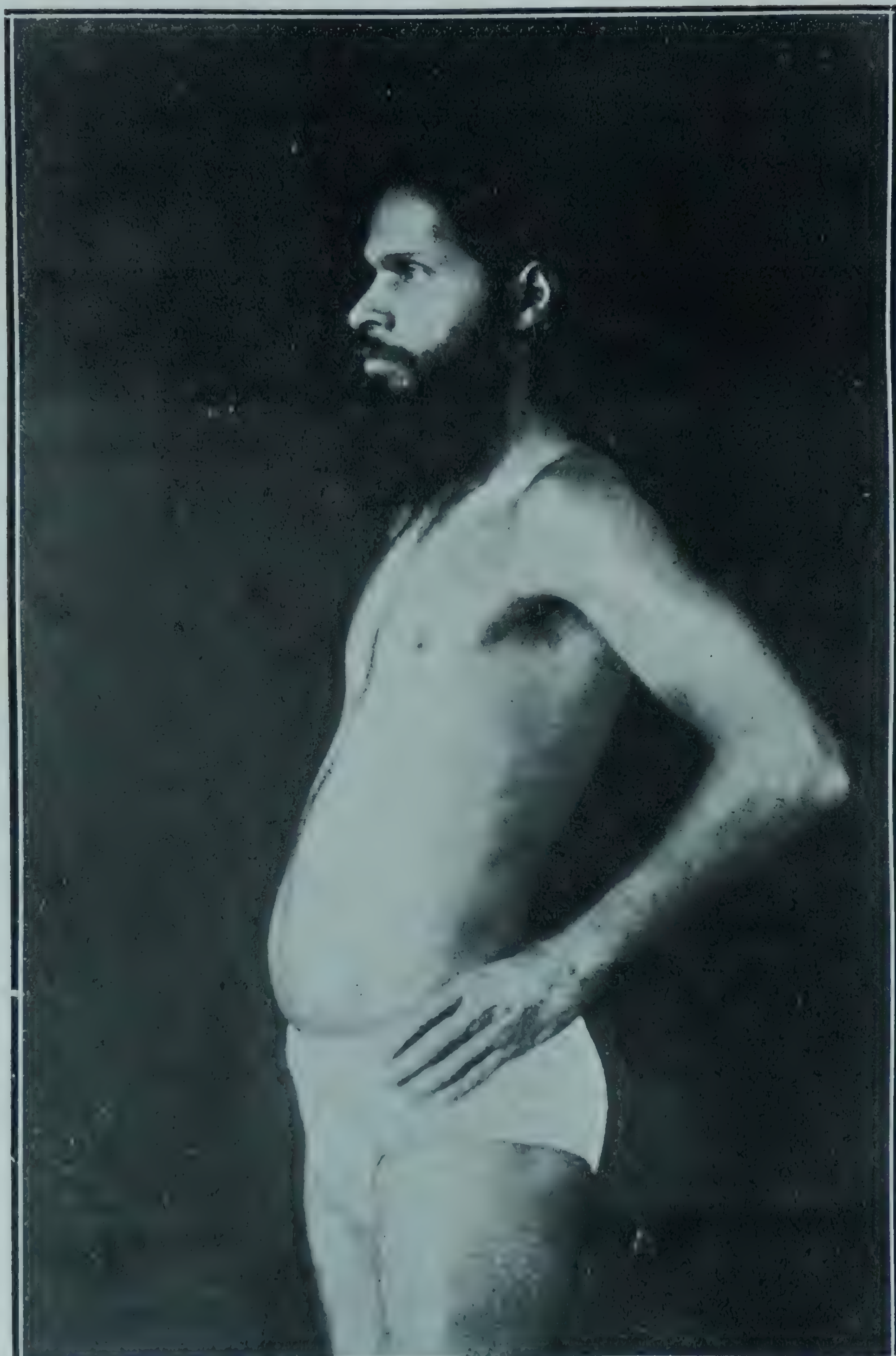
Having noted these physiological facts, let us now proceed with the examination of Mr. Muller's statement.

As we have seen his proposition is that the diaphragm can not be moved *voluntarily* and that it has to be moved either by moving the ribs or the abdominal muscles. We shall take the two parts of this statement separately.

A reference to the experimental evidence produced in this issue, will at once show that the diaphragm *can* be moved *voluntarily*.

1 We are not here concerned with this movement.

Fig. LIV



Abdomen Skiagraphed in Experiment VIII

Experiment VI was performed after ordinary expiration, and Radiograph X represents the position of the diaphragm and the ribs at the end of normal expiration. In this position the diaphragm stands in a relaxed condition. To move it is to get it to work or to contract it. It is a well-known physiological fact that the diaphragm lowers down when it contracts. This has been done in Experiment VIII where the diaphragm is lowered through its downward normal range. The lowered diaphragm can be observed in Radiograph XII which represents Experiment VIII. A comparison between Radiographs X and XII will clearly show that the diaphragm has been considerably lowered. (Vide sections 2, 3, 4 and 5 on pp. 185 and 186.)

Now we will proceed to show that this lowering of the diaphragm has not been accomplished by the movements either of the ribs or of the abdominal muscles, as Mr. Muller would have it according to the second part of his statement, but has been brought about *voluntarily*, that is, merely by an effort of will.

Taking first the ribs, we find that the lowering of the diaphragm shown in Radiograph XII has been secured without moving the ribs at all. A comparison of the positions of the ribs represented in Radiograph X and Radiograph XII clearly proves that the ribs have not moved from their places, and yet the diaphragm has been lowered down. (Vide sections 7 and 8 on p. 187.) So we cannot say that the diaphragm has been moved by the ribs.

Next we go to the abdominal muscles. There is ground to believe that Mr. Muller would attribute the lowering of the diaphragm as shown in Radiograph XII to be due to the movements of the abdominal muscles. We shall see how.

In his statement quoted at length in the last issue Mr. Muller says, "I know that many people will assert that such movements as are illustrated in Figs. 44[1] and 45 are caused by the diaphragm; but it is impossible to explain how the diaphragm

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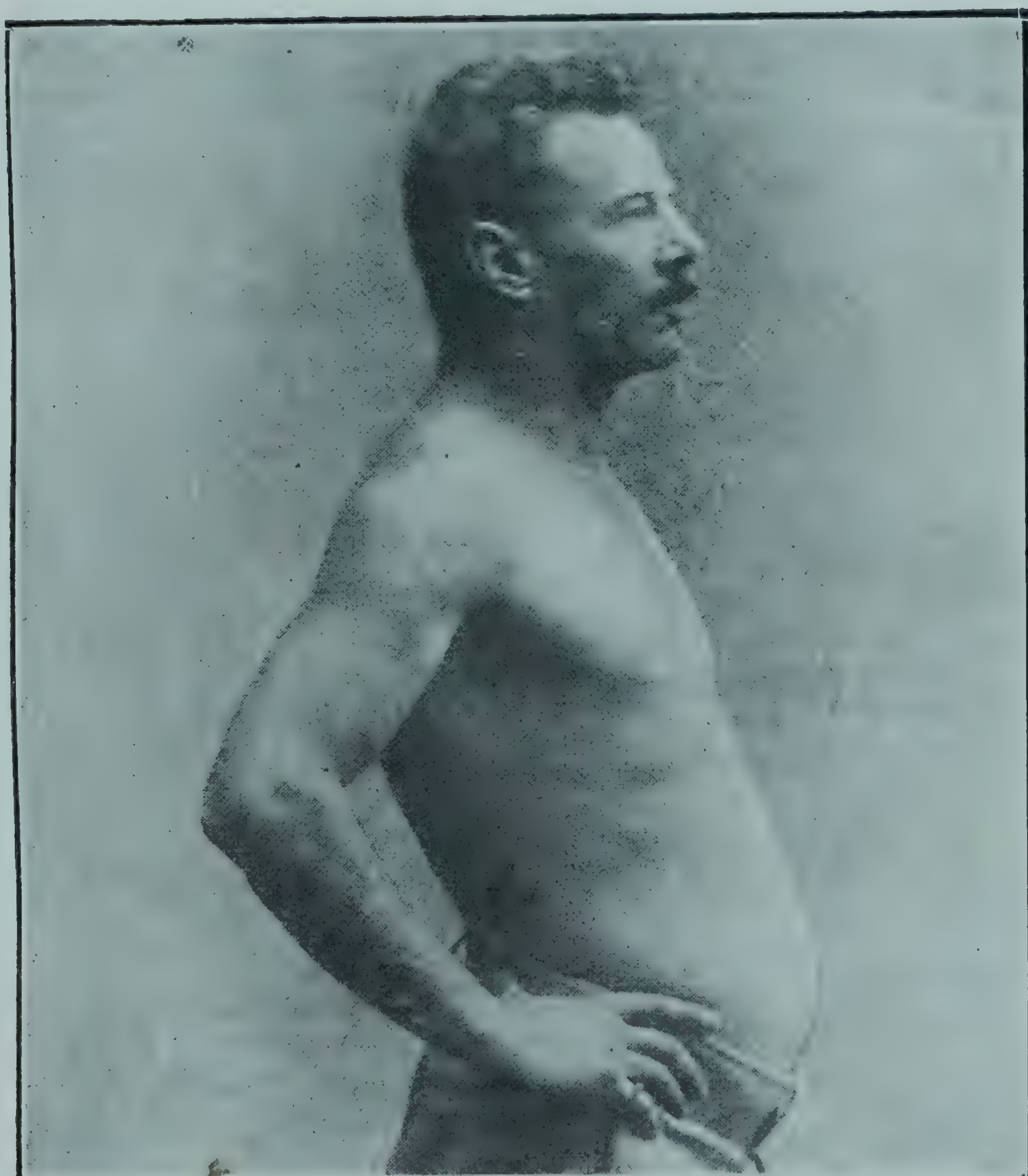
1 Reproduced in this volume as Figs. IV and V respectively. The same is again given in this issue as Fig. LV.

can achieve such results. And there is surely no reason why the diaphragm should perform a thing which is easily done by the abdominal muscles." Now so far as the abdomen is concerned, the movement illustrated in Fig. LVb is exactly the position skiagraphed in Experiment VIII and is available for inspection in the form of Radiograph XII. It will be remembered that this radiograph was taken when the diaphragm was lowered after normal expiration, the glottis being kept closed. Fig. LIV illustrates the abdomen skiagraphed in Experiment VIII. We know that Mr. Muller's picture is taken after inhalation and our picture is taken after exhalation. But our readers on comparison between Figs. LIV and LV, will immediately see that the abdomen presents the same appearance in both the cases, the inhalation in one and the exhalation in the other, being observed in the different forms of the chest. In both the cases the abdomen stands bulging out.

Now according to Mr. Muller this bulging out of the abdomen is accomplished by the movements of the abdomen and not by the diaphragm, and according to our view it is accomplished not by the abdominal muslces but by the diaphragm. We now want to see which of the two views is correct according to modern science.

Even an ordinary student of anatomy knows that if the abdominal muscles start working, they are contracted, as every muscle that works must, and these depress the abdomen. Fig. 44 of Mr. Muller reproduced as Fig. IV in the first issue of this volume represents the abdominal muscles in action. So also it is a matter of common knowledge amongst anatomists that the abdomen can be protruded only by relaxing the abdominal muscles and not by getting them to work. The abdominal muscles in relaxation are pressed forward by the abdominal viscera which in their turn are pushed forward and downward by the descending diaphragm. And thus only the abdomen can bulge out. Mr. Muller's view appears to be that the abdomen can both be protruded as well as depressed by the actions of the abdominal muscles only. But this is obviously wrong. No muscles can act in relaxation and unless the abdominal muscles are in relaxation, the abdomen can-

Fig. LV



Muller's Correct Pose for Abdominal Inhalation.

not be pushed forth. So the lowering of the diaphragm observed in Experiment VIII cannot be attributed to the action of the abdominal muscles. We have already proved that it is not also due to the movement of the ribs. So both the possibilities suggested by Mr. Muller being disproved, we have to accept the conclusion that the diaphragm has been lowered down by the force of will and that its action is thus voluntary and independent of both the ribs and the abdominal muscles.

In his discussion Mr. Muller has advanced a very strange argument to prove that the diaphragm is an involuntary muscle. He means to say that every man should have been able to locate the exact anatomical position of the diaphragm had it been a voluntary muscle; but as ordinary man fails to identify this position, the diaphragm must be an involuntary muscle.[1] Mr. Muller looks to be under the impression that the working of every voluntary muscle must enter into the consciousness of an individual and consequently every person must be able to point out the exact anatomical position of a voluntary muscle. But this impression is wrong. There are a number of voluntary muscles in the body of whose work man never becomes conscious. Take for instance the muscles psoas major and psoas minor. The function of these muscles is to flex the thighs upon the trunk. Now no man lifting up his thighs is ever conscious of the work done by these muscles. Hence Mr. Muller's argument has absolutely no force.

It is somewhat surprising to find that Mr. Muller does not take into consideration even the histology of the diaphragm in discussing whether it is a voluntary or an involuntary muscle. Had he done this, he would have immediately found that there is not the slightest ground to think that the diaphragm is an involuntary muscle.[2]

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1 "The direct proof of the fact that *nobody can move his diaphragm voluntarily*, (Italics ours), or come into direct nervous contact with it, is that all the sensations which people imagine that they have in the diaphragm are always actually in the abdominal wall, or perhaps in the stomach or intestines. If you ask a person to point out where he thinks his diaphragm is he will, in nine cases out of ten, put his finger near the navel, or at all events not higher than on a level with the openings of the lower pockets of his waistcoat. But the diaphragm is really situated much higher on the front of the chest, above the point of the breastbone, that is, on a level with the upper pockets of the waistcoat."

2 Vide our note on muscle; pp. 195 and 196 of Vol. 1.

Summing up the discussion we find that either the diaphragm or the ribs can be raised without lowering the other and that the diaphragm can be moved independently either of the ribs or of the abdominal muscles.

PART II

A Few More Points of Interest

In the first part of this article, we have explained the points of difference between the medical scientists and ourselves on the one hand, and between Mr. Muller and ourselves on the other, having tried to show how our point of view is proved by the scientific evidence we have adduced. In this part of the article, we wish to note a few more points of interest regarding the diaphragm and the ribs and especially the former. We wish to study here the movements of the diaphragm in relaxation and in the course of this study, we shall see how the ribs help this movement.[1]

It has been made clear that the diaphragm does not depend upon the ribs *in its action* but acts voluntarily. In one stage of its relaxation, however, its movements do depend upon the movements of the ribs. It must be borne in mind that this has nothing to do with the view of Mr. Muller. According to him the ribs directly move the diaphragm mechanically even in its contraction, whereas according to this view the movements of the diaphragm in its relaxation are brought about by pressure changes[2] in the thorax and in the abdomen, which pressure changes are due to the movements of the ribs. We shall now start with the study of the relaxing diaphragm.

But before we do so, let us note one more point. The importance of the manipulations of the diaphragm in Yogic practices

1 Non-medical readers will do well to digest our 'Note on Respiration' before they start reading this part of the article.

2 For pressure changes in the thorax and abdomen read our 'Note on Respiration' in this issue.

lies in the pull which its crura and the neighbouring fibres are able to give to the sides of the vertebral column, because through this pull the students of Yoga are able to work directly upon the sympathetic and the central nervous systems. We shall treat this point at greater length in the next issue.

Coming to the study of the relaxing diaphragm, we find that this muscle starts relaxing when exhalation begins. The elastic recoil of the lungs reduces their size allowing the ribs to sink roundabout them and the diaphragm to rise from below. This rising diaphragm is in its turn followed by the abdominal viscera which are pressed upward and inward by the contraction of the abdominal muscles. At the end of the normal exhalation, the diaphragm reaches its normal relaxation. This marks the first stages in the diaphragmatic relaxtion and in this condition either the crura or the neighbouring fibres do not exert any pull upon the sides of the vertebral column.

The second stage in the relaxation of the diaphragm is begun when forced exhalation starts and is completed when the forced exhalation is the deepest. In this condition the ribs are pressed in reducing lateral and dorsoventral diameters of the lungs. The abdominal muscles press tightly upon the abdominal viscera and push them inward and upward. These viscera in their turn push up the diaphragm which becomes further relaxed. The verticle diameter of the lungs is also reduced by this rise of the diaphragm. Whether the crura and the neighbouring fibres of the diaphragmatic muscle exert a pull upon the sides of the vertebral column in this position is not known.

The third and the final stage in the relaxation of the diaphragm is started when an attempt is made at Uḍḍiyāna, and is completed when Uḍḍiyāna reaches its highest degree. In this condition the ribs are raised. The rising ribs increase the lateral and dorsoventral capacity of the thorax and thereby reduce the intra-thoracic pressure. The lungs closely following the ribs experience a lateral and dorsoventral expansion. The reduction in

the intra-thoracic pressure pulls up the diaphragm still higher, till at last *most probably* the intra-thoracic and the intra-abdominal pressures equalize themselves. In this third stage of relaxation the crura and the neighbouring fibres give a powerful pull to the sides of the vertebral column.

It is to be noted here that the first stage of the relaxation and rise of the diaphragm is due to the retracting lungs. The second stage is due to the push given by the abdominal viscera and the third stage is due to the reduction of the intra-thoracic pressure brought about by the raising of the ribs. In none of these stages the upward movement of the diaphragm has been the result of the sinking ribs.

The Semi-Scientific Section

N. B.—The Director of the Kaivalyadhāma entreats every man of means to show his active sympathy for the Ās'rama.

A NOTE ON RESPIRATION

(Concluded)

Up to now we have studied the bony structure of the external nose as well as the nasal cavities. Now we have to note that these hard surfaces are covered over with mucous membrane. This mucous membrane is a continuous piece that lines not only the inside of the external nose except the vestibule, but it also clothes the floor, the roof and the walls of the nasal cavities and continues into the pharynx. When we examine this mucous membrane covering the nasal cavities, we find that functionally two areas are to be mapped out. The upper area covers one-third of the total surface of the nasal cavities and the lower area the remaining two-thirds. Having the sense of smell situated in it, the upper district is called the *olfactory region*, the lower district being called the *respiratory region*, as it constitutes the passage of air breathed in and out during respiration. That means the cavities of the nose have got two separate tracts for the two functions they perform. If we divide the height of the nostrils into three equal parts, the uppermost part is used for smelling and two lower parts are used for breathing. None should suppose, however, that the uppermost part is not at all available as a passage for respiration. Although in the normal and quiet breathing only the lower two parts are used, in forced breathing the upper third is also utilized. The sense of smell, however, is confined to the upper third only, having nothing to do with the lower two regions. This is because the sense of smell depends upon the presence of the olfactory nerve endings which are distributed only over the upper third area.

Two features which distinguish the mucous membrane covering the olfactory region from that covering the respiratory tract, deserve our attention here. The mucous membrane which clothes the respiratory tract is thick and spongy whereas that which lines the olfactory region is softer and more delicate. The other

distinguishing feature is the very great vascularity of the respiratory tract. In fact it is marked by the presence of a rich venous plexus. These anatomical facts have a physiological significance. As noted above in ordinary quiet breathing, the air moves through the lower two-thirds of the nasal area. The air in the upper one-third is scarcely disturbed. Now that portion of mucous membrane which lines the passage of the air must be stouter than the portion where the air is stationary during the hours of normal breathing. The greater vascularity of the respiratory tract has also a purpose to serve. When external air is to be breathed into the lungs, it must be warm and moist, otherwise it may have an injurious effect upon the delicate structure of the lungs. Now the large supply of venous blood which is present in the plexus situated in the respiratory region, raises the temperature of the air being inspired and also moistens it.

It has been stated above that the sense of smell is situated in the upper one-third of the nasal cavities. This sense consists of very fine nerve filaments from twelve to twenty in number. They are distributed like a thick brush both on the septum and the lateral walls. Here these nerves descend through the ethmoid bone which, as we have seen above, separates the nasal cavities from the brain. Through the ethmoid the olfactory nerves are connected with the olfactory bulb which in its turn is joined to the base of the brain through the olfactory tract. Fig. XXXII appearing in the last issue illustrates the olfactory nerves, the bulb, the tract as also the base of the brain. When the fine endings of the olfactory nerves are stimulated by particles carrying odour with them, sensation of smell is experienced.

Following facts may be remembered with advantage in regard to the sense of smell.

The delicacy of the sense of smell is very remarkable. It has been calculated that even $\frac{3}{1,000,000,000}$ of a grain of musk can be distinctly smelt.

But when the particles issuing from an odoriferous substance are very few, their presence in the air may not be appreciated in

normal breathing. Because they pass through the respiratory passage only and are not presented to the nerve endings in the olfactory region. If under such circumstances a sudden sniff is made, air is forced even into the olfactory tract and the faint odour can be detected.

Even a liberal proportion of odoriferous particles in the air may fail making itself felt. For the sense of smell to be excited, the mucous membrane must be neither too dry nor too moist. So when one catches cold his sense of smell is dulled owing to the presence of excessive moisture. There is another reason also why one does not smell properly during cold. The swelling of the mucous membrane covers the nerve filaments rendering them inaccessible to the odoriferous particles.

It is a matter of common experience that perfumes make the strongest impression to start with. Afterwards they grow fainter and even their presence is lost upon us, if we continue long to be in their presence. This circumstance can be accounted for by the fatigue of the sense of smell. The olfactory apparatus is soon exhausted and fails us on that account. If, however, we take a round in the fresh air, the apparatus is refreshed and we can again appreciate odours.

The Pharynx—It has been stated above that the nasal chambers posteriorly open into the throat. These openings are situated above the soft palate and below the base of the cranium. This portion marks the beginning of the pharynx. Now if our reader again looks into the mirror with his mouth widely opened, he will observe that there is something like a wall of flesh covered over with the mucous membrane, stretching behind the tongue and the soft palate. This wall arches above the soft palate in something like a dome. It is exactly under this dome that the posterior openings of the nose are located. Below the tongue the wall descends in the form of a sack that ends in two openings, one of which leads to the œsophagus and the other to the larynx. From the backward openings of the nasal chambers to the lower openings leading to the œsophagus and the larynx, the

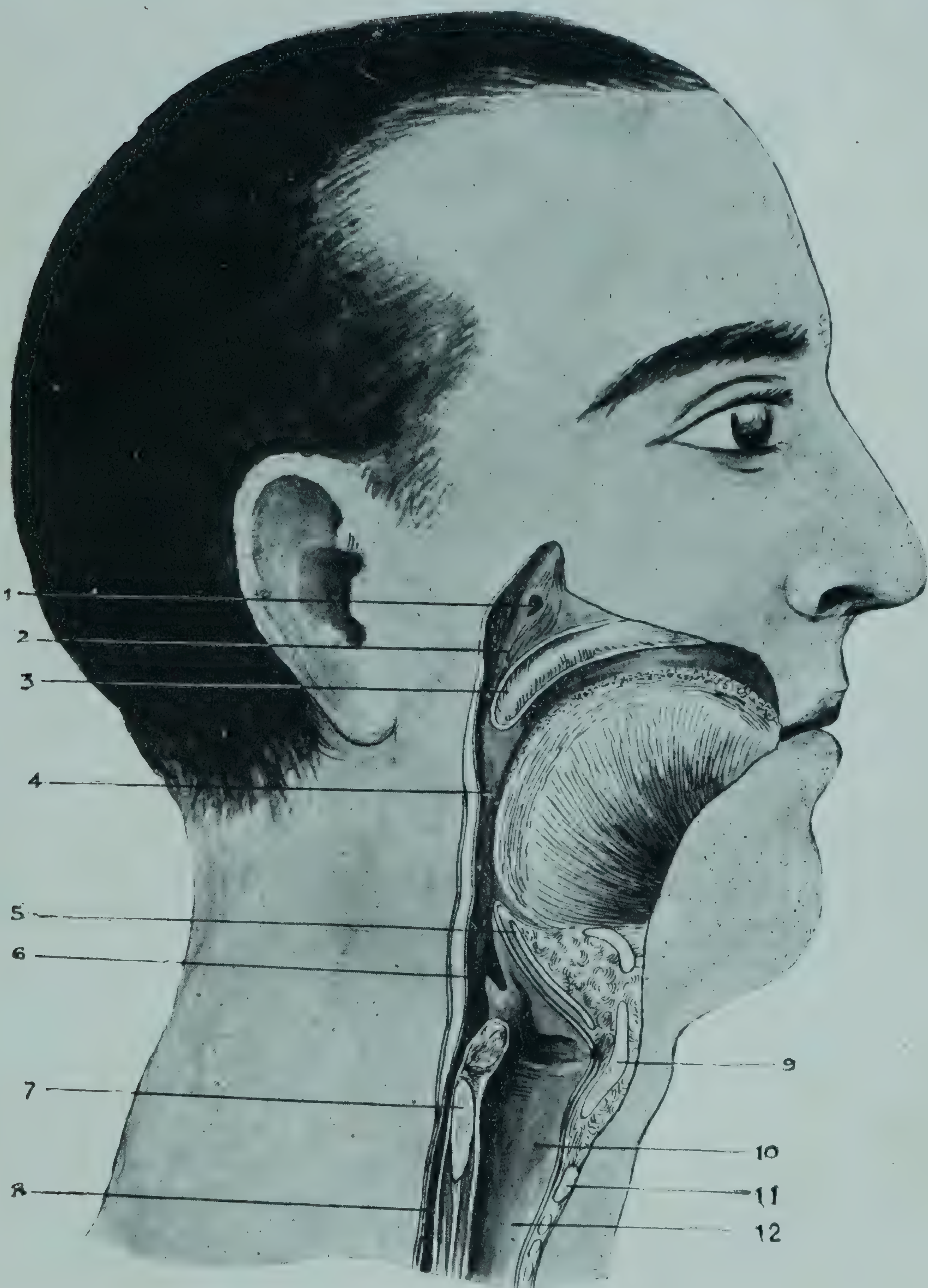
same canal stretches continuously and is known as the *pharynx.* (See Fig. LVI). Our reader need not be told that the mouth is only an opening in the anterior wall of the pharynx. So up to now we have noticed five openings of the pharynx, two nasal, one oral, one œsophageal and one laryngeal. There are two more orifices which pierce the pharynx. They are situated in the side walls of the pharynx, one on each side, above the soft palate. They are called *Eustachian orifices,* because they mark the openings of the Eustachian tubes which run to the cavities of the ears. (Vide p. 134 of the first volume). The portion of the pharynx that is situated above the soft palate is called the *nasal part* of the pharynx, that situated behind the mouth and the tongue is called the *oral part,* whereas the remaining portion is called the *laryngeal part.*

The pharynx is used for the passage of the air as it is breathed in and breathed out. In inhalation the air drawn through the nasal cavities passes across the nasal and oral parts of the pharynx and then getting down the larynx goes into the trachea and the lungs. In exhalation the air expelled from the lungs follows the reverse path. At the time of breathing the œsophagus as well as the Eustachian tubes remain closed and the possibility of the air going a wrong way is avoided. Again the soft palate leaves, between it and the back wall of the pharynx, an opening sufficient for a free movement of the flowing air. Hence there is no obstruction in the way of respiration.

At the time of speaking, however, the soft palate completely covers the upper part of the pharynx, so that no air can find its way upward into the nasal part. But in some persons, the soft palate is defective, there being a small cleft in it. When these people attempt speaking, some of the air from the lungs escapes through this cleft above the palate; and finding its way through the nasal passages that are ever open, adds nasalized element to their voice.

Our reader knows that he uses a part of the pharynx also for swallowing. Food travels through the oral part into the laryngeal pharynx and then gets into the œsophagus. The question

Fig. LVI



The Pharynx Exposed.

1 Orifice of the Auditory Tube. 2 Nasal Part of the Pharynx. 3 The Soft Palate. 4 Oral Part of the Pharynx. 5 The Epiglottis. 6 Laryngeal Part of the Pharynx. 7 Cricoid Cartilage. 8 The Œsophagus. 9 Thyroid Cartilage. 10 The Larynx. 11 Cricoid Cartilage. 12 The Trachea.

is why food going down the pharynx does not run into the larynx and is always pushed down the œsophagus. For this purpose we have to refer to a small organ named *epiglottis*.

The epiglottis is situated at the root of the tongue (vide Fig. LVI), and serves as a cover for the larynx in times of need. In the act of swallowing, the larynx is raised, and the descending morsel lowers the epiglottis which meeting the raised larynx completely covers its mouth. Thus the larynx being closed, food finds its way to the œsophagus or gullet. The rising of the larynx can be felt by anybody by placing his fingers on the middle of his throat and imitating the act of swallowing. If, however, through mistake, even a small particle of food gets the wrong way, we mean gets into the larynx, violent coughing ensues, the system forcibly trying to expel the intruder. Food does not get into the nasal part, because the soft palate completely shuts out that portion during the act of swallowing.

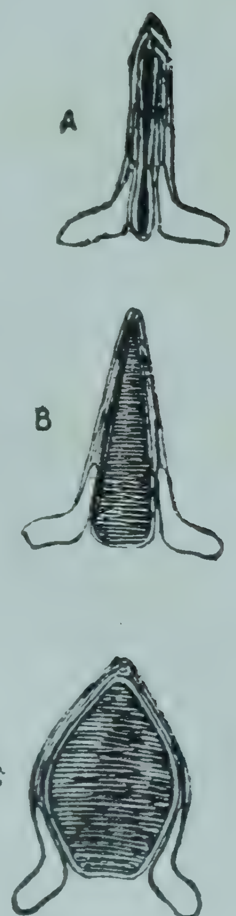
The mucous membrane covering the nose is continuous with the pharynx. It is also to be noted that it continues to cover all the passages leading from the pharynx It is this circumstance which makes a trouble starting with the throat very often spread to the nose, ear and larynx. That is why running of the nose, deafness of the ear and coughing, are on many occasions seen going together.

THE LARYNX—We have noted above that the pharynx has two passages opening from its lower end. They are the œsophagus and the *larynx*. Both the œsophagus and the larynx pass through the neck, the former is situated in the posterior part of it, whereas the latter is situated in the anterior portion. The larynx begins in front of the third cervical vertebra and extends across the fourth, fifth and sixth. The œsophagus starts in front of the sixth cervical. Hence it will be clear that the larynx stands higher up in the neck than the œsophagus. (See Fig. LVI). As the œsophagus remains constantly closed except at the time of swallowing, the air coming down the pharynx gets into the larynx which is always open for this purpose, being closed only during the act of swallowing.

We have already seen that the larynx is situated in the front portion of the neck. It is a box-like anatomical structure made of different cartilages, and measures less than two inches. Two of these cartilages can be felt even from outside the throat. Starting from the jugular notch upward and feeling the surface of the throat with our fingers, we meet with the first prominence at a short distance. This is the cricoid cartilage. (See Fig. LVI). Travelling further up we come across the next prominence, visibly projecting especially in the case of thin persons. This is the thyroid cartilage, the prominence being popularly known as *Adam's apple.* These and other cartilages including the epiglottis which is also a cartilage, are held together by muscles which move them according to the needs of the situation. We have already learnt how the larynx is raised and the epiglottis lowered, during the act of swallowing. As soon as the swallowing is over the larynx is lowered, and the epiglottis raised, leaving the passage free for the air moving to and fro during respiration.

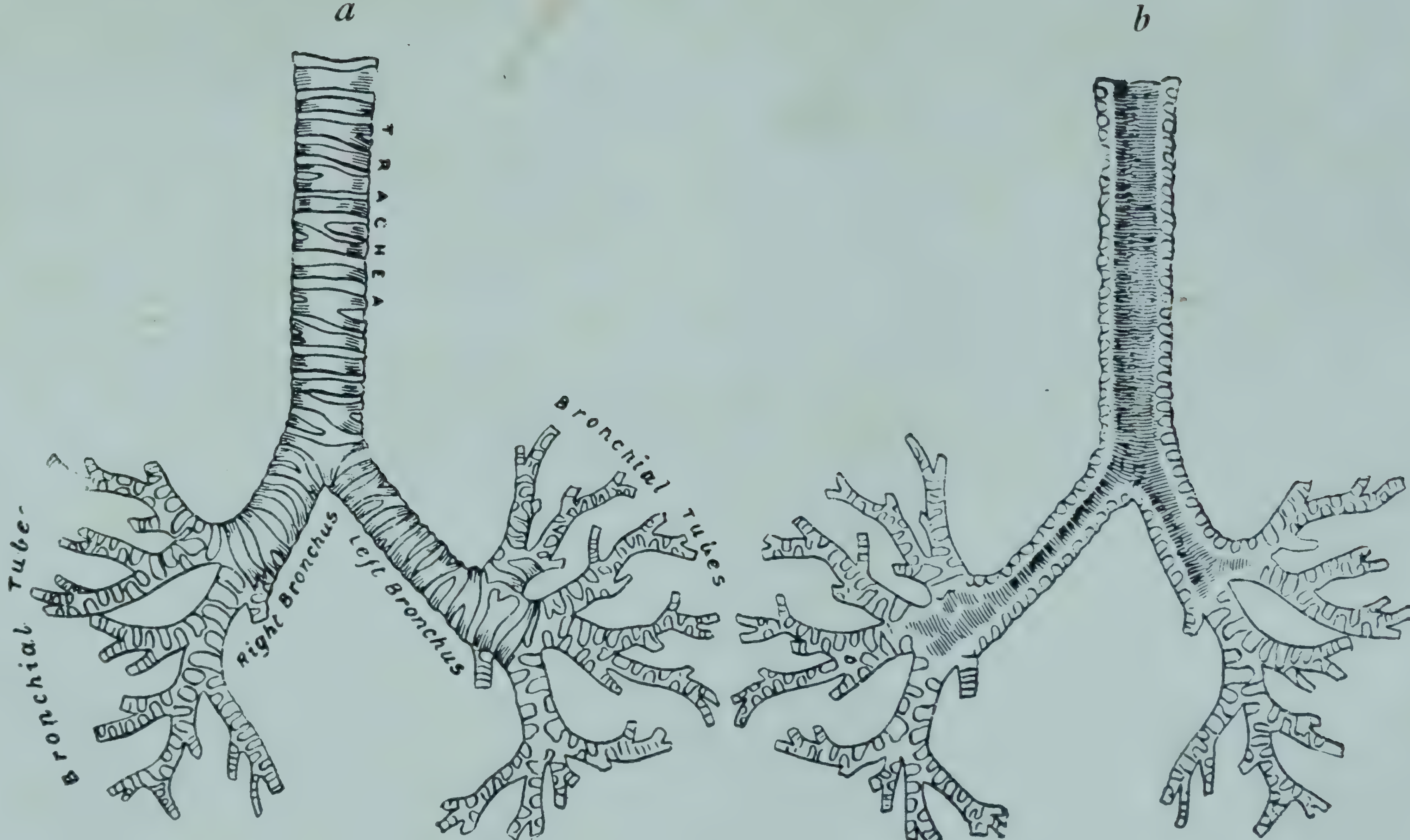
The larynx is popularly known as the voice box. We want to see now how this box-like instrument is responsible for human voice. Like the pharynx the larynx is covered with mucous membrane on its inner surface, the mucous membrane that covers the pharynx continuing to cover the larynx also. This mucous membrane is thrown into several folds. Two of these start from the front of the box midway in its height, and stretching across its cavity, join the opposite side. These folds are very thin. They are joined together in the front, but are capable of being separated from behind. These folds are situated just behind the thyroid cartilage already referred to. *A* in Fig. LVII represents these folds as they stand close together and *C* as they stand wide apart, *B* illustrating the middling position. The three pictures indicate the appearance of the folds that they would present to a man peeping into the larynx from above. These folds admit of being brought so tightly together, that they can completely shut up the air below even at a high pressure. These folds are cap-

Fig. LVII



The Vocal Cords.

Fig. LVIII



The Trachea and the Bronchial Tubes.

able of undergoing different degrees of approximation. During normal respiration they stand apart and the passage of the air is smooth and noiseless. But when they are brought close together the air passing through the narrow chink formed by them, throws them into vibrations which in their turn throw the passing air into ripples. It is this rippling air that produces the sound when it strikes our ear. Thus being responsible for the human voice these folds are called *true vocal cords,* the narrow chink between them being called the *glottis.* These vocal cords are called *true* because they are to be distinguished from another pair of similar folds situated just above them, which are called *false vocal cords,* because they are not concerned in the production of voice.

The mucous membrane which forms the true vocal cords by forming itself into two thin bands, continues to cover the lower portion of the larynx and extends into the trachea into which the larynx opens.

THE TRACHEA—The trachea or the windpipe is a tube-like anatomical structure some four inches in length. It starts at the bottom of the larynx from behind the cricoid cartilage and extends down into the chest just behind the breastbone. In thin persons the upper part of the trachea may be felt with our fingers below the cricoid cartilage. The diameter of the trachea is something like an inch.

The tube of the trachea is formed by cartilaginous rings, from sixteen to twenty in number, which are arranged one above the other, and which are held together by an elastic fibrous membrane in which they are enclosed. These rings are not entire but are deficient in part. They are arranged in such a way that the circular part is placed in front and deficient part is placed behind. Of course the deficient part of the tube is covered by the fibrous membrane which clothes the whole trachea. Fig. LVIIIa represents the appearance of the trachea as seen from the front and Fig. LVIIIb illustrates the appearance of the same as seen from behind.

It has been stated above that the œsophagus is placed just behind the trachea. In fact the membranous part of the trachea

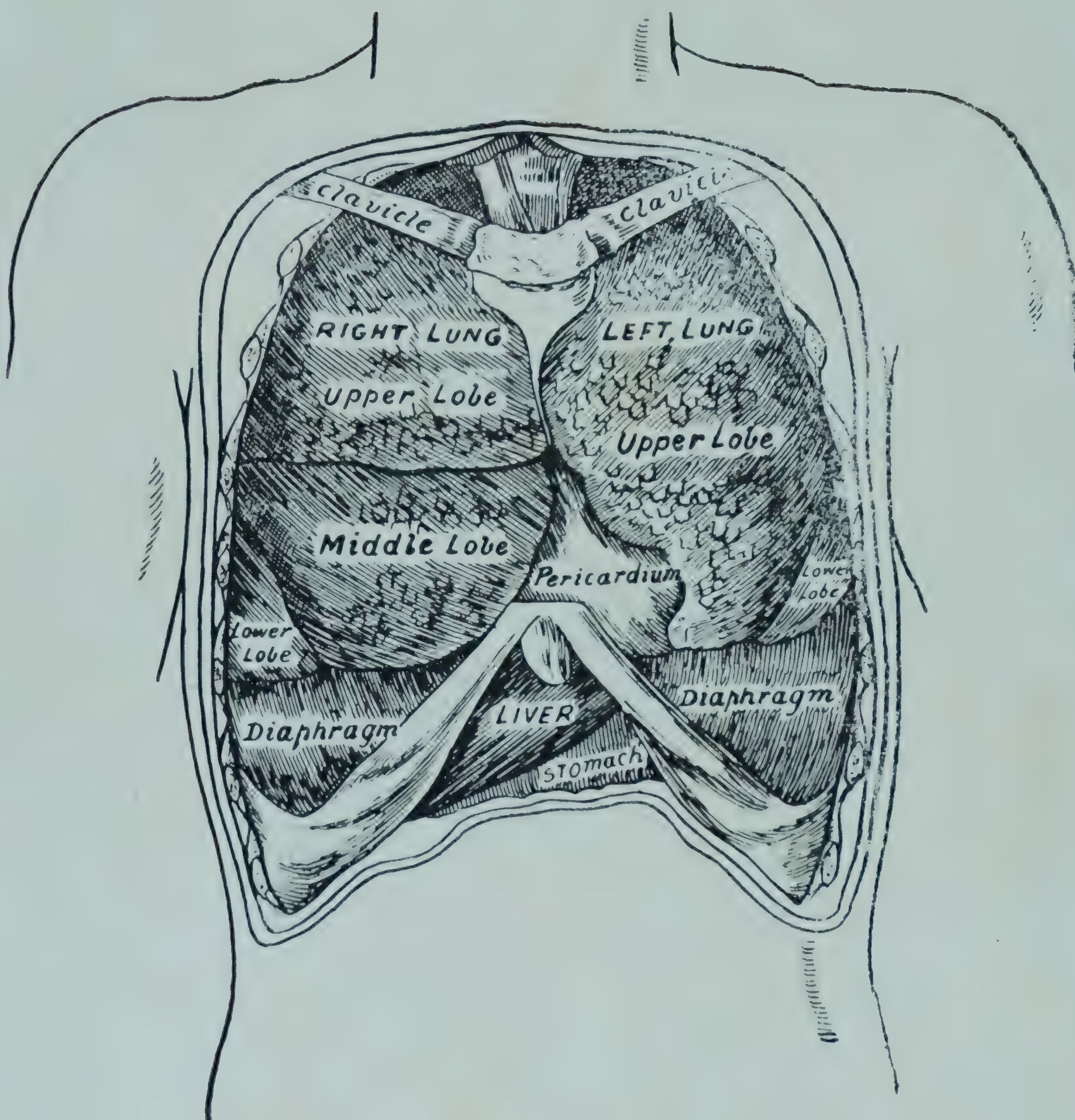
and the œsophagus run together. Hence any obstruction in the œsophagus produces a sense of suffocation, although the air passage is free.

A large number of mucous glands is situated in the mucous membrane of the inner surface of the trachea. Under normal conditions the mucous secreted by these glands keeps the passage moist. But if there be an excessive secretion of mucous, it is ejected immediately. The inner mucous membrane of the trachea is lined with ciliated epithelium.[1] These cilia always maintain an upward movement and thus slowly sweep up the secretions towards the larynx from which they are coughed out.

THE BRONCHIAL TUBES—The trachea when it descends into the chest to the level of the fifth thoracic vertebra, is divided into two tubes called the *bronchi.* The tube on the left side enters the left lung and is known as the *left bronchus,* that on the right side entering the right lung being called the *right bronchus.* (See Fig. LVIII). After entering into the substance of the lungs, each bronchus divides itself into several branches, these branches again dividing themselves into smaller tubes. These divisions and subdivisions continue to penetrate the substance of the lungs through and through, till at last the tubes become so small that their diameter hardly measures $\frac{1}{40}$th of an inch. The trachea with the two bronchi and the numerous smaller and still smaller branches spreading out from them would, if they are separated from the lungs, present the appearance of an inverted tree with the main stalk pointing upward. (Vide Fig. LVIII). When the tubes are reduced to $\frac{1}{40}$th of an inch in diameter, they stop subdividing themselves any more. Here the fine bronchial tubes widen themselves and then end in finer air-cells having a diameter of $\frac{1}{50}$th of an inch only. A bunch of grapes can very well give a graphic idea of the minute bronchial tubes with air-cells clustering roundabout them. When the air that comes through the nostrils, the pharynx, the larynx, the trachea and the bronchial tubes successively, re-

1 Epithelium is the delicate tissue forming the outer layer of the mucous membrane. Cilia are very minute hair-like vibrating organs on the surface of the epithelium.

Fig. LIX



The Thorax Exposed.

aches the air-cells, its further passage is stopped. From these cells it is diffused into the blood. But before we study this diffusion, we shall note a few important points about these bronchial tubes.

We have seen above that the trachea is made up of cartilaginous rings. Similar cartilaginous portions are present throughout the bronchial tubes except in the last finest branches. The presence of these portions is absolutely necessary for keeping the tubes constantly open for the passage of the air to and from the lungs. Otherwise the tubes would have been exposed to the danger of a collapse.

The fibrous tissue that holds the cartilaginous portions together throughout the length of the bronchial tubes, is very elastic. This circumstance helps the tubes to adopt themselves to the movements of the surrounding anatomical parts.

As in the trachea so in the bronchial tubes, the inner mucous membrane is lined with ciliated epithelium. The mucous glands imbeded in the mucous membrane, keep the air passages moist under healthy circumstances. But in disease when the secretion is excessive, the bronchial tubes stand in the danger of being blocked up. Here the cilia try to help the situation. By their perpetual upward movement they work up the secretion up to the larynx. This organ is immediately irritated and throws out the secretion by a cough.

The Lungs—In the previous section we have referred to the air-cells. These air-cells are matted together by means of fibrous tissues. Blood-vessels running through these cells divide and subdivide themselves into myriads of capillaries covering these air-cells. Again there is a network of nerves spreading throughout these structures. All these parts, the cells, the blood-vessels and the nerves form themselves into two masses of a spongy substance each of which is called a *lung*. We shall now study these statements in a greater detail.

Alveoli is another name for the air-cells. All the alveoli developing themselves roundabout a fine bronchial tube, presenting

the appearance of a bunch of grapes, go to form what is called an *ultimate lobule*. Several ultimate lobules constitute a *lobule* and several such lobules are contained in a *lobe*. The right lung has three such lobes and the left has two. (See Fig. LIX).

The walls of the air-cells which cluster round the finest bronchial tubes, are made of very elastic and circular muscular tissue. The walls are, however, extremely thin, so much so that the air which flows into the cells through the air tubes, is very freely diffused through these walls, although its direct passage is blocked up here.

We have referred to the myriads of capillaries that cover the air-cells. These are the finest ultimate subdivisions of the blood vessels coming into the lungs and going away from them. The incoming vessels bring impure blood from the heart, to be purified in the lungs. The outgoing vessels carry the purified blood from the lungs back to the heart. Now the network of capillaries which covers the air-cells is extremely fine, and the walls of the capillaries are extraordinarily thin. So when we consider an air-cell, we find that inside the cell there is a stock of fresh air which is surrounded by two extremely thin layers of tissues, the first belonging to the cell and the second pertaining to the capillaries. Beyond these layers is the blood streaming through the capillaries in very very fine currents. The two intervening layers, even when put together, are again so thin, that they allow a free interchange between the oxygen from the cells and the carbon dioxide from the capillaries.

The number of blood capillaries which surround the air-cells is so large that it passes all imagination. It is calculated that these capillaries from the two lungs would connect Bombay with London, if they were stretched out in one single line ! We can, however, understand the necessity of this huge length of capillaries, when we know the amount of blood that is presented through them to the air-cells for purification. If the quantity of blood present in the lungs at a particular moment, is spread out in a very thin layer, it would cover as many as one thousand square feet at least ! So we find that the arrangement of the air-cells

and the capillaries," is to secure a very large surface area for the lungs, within such small limits as the chest of a human being.

This description of the lungs would not be complete unless we explain the two coverings in which the lungs are clothed and which form air-tight bags for holding them. These coverings are called the *pleuræ* and consist of a serous membrane, that is, a smooth glistening membrane that secrets a lubricating fluid. Each lung has a separate pleura of its own, which is folded double, so that the two layers cover the lung completely. Thus an air-tight double bag, having two sheaths one inside the other, of serous membrane is prepared, and each lung is held within this bag. Our reader knows that the lungs are placed inside the thorax. Now the outer layer of the pleura lines the inner surface of the thoracic cavity, and is called the *parietal layer*. The inner layer is adherent to the lungs, and is called the *visceral layer*.

A tolerably good idea of the relations of the lungs, pleuræ and the thorax can be had, if we compare these with a football. The coarse leather bag which forms the outer covering of a football, very well illustrates the rough thorax. Inside this leather cover there is the rubber bag which when the ball is to be used is kept inflated. Now instead of one bag let us suppose that there are two rubber bags one inside the other. When air is pumped into these bags they will swell up. In this inflated condition the outer bag will adhere to the rough leather covering in which these bags are held, and the inner bag will lie closely along the outer rubber bag. The two layers of the pleura lie exactly like the two rubber bags in relation to each other. The only difference is that in the case of the pleural layers there will always be a sort of lubricating fluid secreted by the membrane that allows the two layers to glide smoothly on each other during the constant movements of respiration. Again in the case of the football, the inside is hallow, whereas in the case of the pleural layers, the inside is filled with the spongy substance of the lungs. Needless to point out that the tube of the rubber bags through which air is pumped in, may fitly illustrate the trachea.

The space between the two layers of the pleuræ is called the *pleural cavity*. Under normal conditions of health, the two layers stand so close together, that there is no space left between them. But during inflamatory changes of the membrane, as in pleurisy, the cavity becomes enlarged by an increase in the amount of fluid which it contains.

We have said above that the lungs are held in the thorax. But the lungs are not the only organs situated there. Besides these there are the heart, the big blood-vessels, the trachea and the œsophagus. These are placed between the two pleuræ, the right and the left, the cavity in which they are arranged being called the *mediastinal cavity*.

The lungs are short in front and longer behind. In front they descend to the sixth ribs whereas behind they stretch up to the eleventh ribs. This position of the lungs is determined by the position of the diaphragm which forms the floor of the thorax. It is to be remembered that above they rise even a little beyond the clavicles. On an average the right lung weighs 22 ounces in an adult, and the left weighs 20 ounces only.

Thus far we have noticed the different organs through which the air moves, when it passes to and from the lungs during respiration. Now we shall consider the muscular and nervous mechanisms responsible for the movements of these organs of respiration, and shall also study the blood-vessels connected with this function.

THE MUSCULAR MECHANISM

"The force expended in opening the chest in inspiration each day is enough to raise the person the height[2] of St. Paul's, and is thus only about one-sixth of the force spent in the circulation. Breathing consists of two acts—*inspiration* and *expiration*. *Inspiration* is a *forced muscular effort* performed by *three* distinct sets of muscles—those that act on the ribs, those that act between the ribs, and the diaphragm, which is the floor of the thorax.

1 In this note, paragraphs included in the quotation marks are extracted from *A. T. Schofield's Articles on Physiology*.

2 Five hundred feet.

"In inspiration the *chest cavity* is made[1] broader, longer and deeper. When at rest, the ribs, hinged behind to the backbone and in front to the breastbone, hang down like the iron handle on the side of a bucket.[2] Now, if we raise such a handle, it not only moves upward, but outward. The same takes place with the ribs; and, in addition, the sternum, or breastbone, being movable, rises forward as well, and thus the chest is made *broader* and *deeper*. It is made *longer* because, when at rest, the diaphragm muscle forms an arched floor, that rises like a dome into the thorax, and on which the lungs rest. As this muscle contracts it flattens[3] the floor, pulls the lungs down, and as a result makes them longer from top to bottom.

"The muscles that raise the ribs are in two sets—those that act on the ribs and those that act between them. The upper ribs are pulled upward by the action of muscles passing down from the neck.

"Between each rib is a double layer of muscles called the intercostal muscles, because they are between the ribs. The top ribs being fixed as these contract, they tend to raise the lower rib, to which they are attached; and thus, by acting together, all the ribs are elevated.

"This constitutes the movement of inspiration.

"In expiration, *the chest returns to its original size* without effort. This is mainly caused by *elastic recoil*. The lungs are full of elastic tissue, which is stretched when the lungs are expanded; and, as soon as muscular effort ceases, the elastic force is so great that the lungs pull the ribs down again, and pull up the floor of the diaphragm.

"When we draw in a breath the abdomen swells out. This is caused by the contraction of the diaphragm, which presses all

1 Increased in the three diameters—lateral, verticle and antero-posterior.

2 See Fig. II of the current volume.

3 As we have seen in the various radiographs and as is now held by the medical scientists, the diaphragm does not flatten during contraction, but descends parallel to itself without altering its convexity. Even then the descent of the diaphragm does increase the vertical diameter of the lungs.

the digestive organs down and makes them bulge out the walls. In expiration the abdomen gets flat again, as the floor rises once more, and the abdominal muscles are contracted.

"The force required to stretch out the elastic tissue in ordinary inspiration is equal to 170 lb.; and the total daily force used in respiration is 21 foot-tons.[1]"

In extraordinary or forced breathing the force required for the act is much more than in normal respiration. Both in inhalation and exhalation additional muscles are brought into play. The additional muscles which are called into action in forced expiration are situated in the neck and chest. In forced expiration the abdominal muscles play a very important part.

It is to be especially borne in mind that speaking, singing, blowing etc., are voluntary expiratory efforts, whereas sneezing, coughing etc., are involuntary. In all these actions the abdominal muscles are brought specially into action.

When one holds his breath after deep inhalation all the muscles of inspiration remain contracted and the glottis is tightly closed. So also it remains tightly closed when one holds his breath after deep exhalation. At this time, however, it is the muscles of expiration that maintain their full contraction.

It is to be noted here that the air outside freely communicates with the lungs when the glottis is open. We have seen above that the glottis remains closed only at the time of swallowing. So during all the twenty-four hours of the day, the air outside communicates freely with the lungs. Now this outside air always stands at an atmospheric pressure, and if it gets communication with a space that stands at a lower pressure, it will flow to that space till the pressures outside that space and inside it become equalized. This is exactly what happens at the time of inspiration. When the lungs become broader, deeper and longer owing to the opening up of the chest, the pressure inside the lungs is lowered and the outside air rushes in through the trachea

1 Force required to raise one ton of weight through twenty-one feet against gravity, or to raise twenty-one tons of weight through one foot against gravity.

till internal pressure becomes equal to that of the atmosphere. This constitutes the act of inspiration.

It has been stated in the foregoing paragraphs that in inspiration the ribs are elevated and the diaphragm sinks, pressing abdominal viscera, thus leading to the bulging out of the abdomen. When the whole muscular mechanism of respiration is healthy, the rising of the ribs and the bulging out of the abdomen are proportionate. But in cases of defective respiratory mechanism, either the abdominal movement or the costal movement is more prominent than the other. This circumstance has led to a distinction in the types of breathing. That respiration in which the costal movement is prominent, is called *costal breathing.* Again the breathing in which the abdominal movement is more in evidence, is called *abdominal breathing* or *diaphragmatic breathing.* The latter breathing bears a double name because the abdominal movements depend upon the movements of the diaphragm.

Due to old age or disease the chest becomes rigid. Under these circumstances the breathing becomes abdominal. People very often, due to their peculiarities of dress, make the movement of the abdomen almost impossible. If this habit is continued over a long time, breathing becomes costal rather than abdominal. Owing to these reasons it is desirable that the whole mechanism of respiration is allowed the greatest scope for movement.

When the chest begins to sink, the pressure inside the lungs is increased and becomes greater than the pressure outside it. Hence air is driven out of the lungs through the trachea, till at last the elastic recoil is completed and again the internal and external pressures are equalized. This constitutes the act of expiration.

Whatever the amount of air inside the lungs either during inspiration or expiration, that air exerts an equal pressure on each of the lungs as a whole; and keeps it, under all conditions, closely in contact with the walls and the floor of the chest.

The number of respirations under normal conditions is between fourteen and twenty per minute.

Having noted the muscular mechanism of respiration, we now proceed to study the nervous mechanism of it.

THE NERVOUS MECHANISM

"The nervous mechanism of respiration is of great practical interest. There are two great centres in the brain where respiration is controlled—the one is the conscious region, under the control of the will, and hence, of course, voluntary; the other is the unconscious region, which is involuntary, and governed in its action by the unconscious mind. The movement of the muscles is controlled from those centres by various nerves, notably the pneumogastric nerve.[1]

"Practically our breathing is under our own control up to the point where life is involved. We can breathe in any manner and at any rate we please. Were it not so, speaking would become impossible. We can also hold our breath up to a certain point; but when life is beginning to be threatened the other involuntary centre comes into play, and, in spite of the strongest effort of will, forces us to breathe. This control also acts continuously when we are not thinking of our breath at all. None of the vital processes require our constant attention; yet with some we are allowed to play up to the point of danger, but no farther."

We shall refer to this nervous mechanism again at the end of this Note.

THE QUANTITY OF AIR WE BREATHE

The quantity of air we breathe depends upon the depth of respiration. In the ordinary normal respiration, the quantity of air that uniformly flows in is about 500 c.c., that is a little more than 30 cubic inches. As much air also flows out during normal expiration. Thus the volume of the tide of air that constantly and uniformly flows in and flows out is about 500 c.c. This is called *tidal air*.

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1 The vagus nerve. The pulmonary plexuses are formed by branches of the vagus and sympathetic.

But if the inspiration were to be deeper, it is obvious that a larger quantity of air will be drawn in. It is estimated that about 1600 c.c. of additional air can be drawn in by an average adult in the deepest inspiration. This additional quantity is called *complemental air.*

Again an average adult can expel about 1600 c.c. of air by a forcible deep expiration over and above the 500 c.c. which he expels in his normal exhalation. This additional air expelled by a forcible deep inspiration is called *reserve* or *supplemental air.*

It is to be noted, however, that even the deepest expiration will not be able to empty the air-cells completely. There will always be a residue of air left in the lungs. This residue is calculated to be equal to 1600 c.c. and is called *residual air.* So we see that in a violent expiratory attempt preceded by the deepest possible inspiration, an adult will breathe out the following quantities—

Complemental Air	1600	c.c.
Tidal Air	500	c c.
Supplemental Air	1600	c.c.
Total—	3700	c.c.

Such a quantity is taken to indicate the *respiratory* or *vital capacity* of man. When we add to this the 1600 c.c. of the *residual air,* we get what is called the *lung capacity* of an individual. Both the vital capacity and the lung capacity are found to vary according to the height and weight of an individual.

Up to now we have seen how we breathe and also how much we breathe. Now we want to see why we breathe at all.

WHY WE BREATHE

A solution of this problem is available in the comparison of the quality of the air we breathe in and the quality of the air we breathe out. The following is the composition[1] of the two types of air—

1 Only those constituents that are important from the physiological standpoint have been compared here.

	Per Nitrogen	Hundred Oxygen	Parts Carbon Dioxide
Inspired Air	79	20·96	0·04
Expired Air	79	16·02	4·38
		4·94	4·34

Here we at once find that the expired air has lost 4·94 parts of oxygen and has gained 4·34 parts of carbon dioxide in going into and coming out of the lungs. Where has this oxygen gone and whence has this carbon dioxide come ? Oxygen has been taken up by the stream of blood that circulates through the lung capillaries and carbon dioxide has been substituted for it by the same agency. If we bring together two vessels containing two different gases without any partition between them, the two gases will mix up very thoroughly.

This very thing happens even if the two gases were to be separated by a thin partition of a membrane. Now we know that the blood streaming through the capillaries around the air-cells and the air in the air-cells, are separated only by a thin partition consisting of the walls of the capillaries and the air-cells. So the gases of the air and the blood mix up very freely. This is what is called the diffusion of gases. In the figures quoted above for comparison, we find that the quantity of oxygen substituted for carbon dioxide, is greater than the quantity of carbon dioxide by ·60 This is because oxygen is used not only in forming carbon dioxide, but also for some other physiological work. Now we proceed to see why the circulating blood current in the lung capillaries, wants to borrow oxygen and tries to lose carbon dioxide.

In this connection we are to remember that the human body is constantly at work even when apparently it is at rest. The circulatory system, the respiratory system, the digestive system etc., know no rest. They have to work ceaselessly. This perpetual work means constant wear and tear ot the body tissues involved in the work. So the loss of the tissues is to be made

good; and waste products are to be removed and thrown out of the body. Now for making good the loss nourishment has to be brought to these tissues. This nourishment consists not only of food and drink, but also of oxygen. Why, oxygen forms the most important factor of nourishment. We cannot live without oxygen even for a few minutes. So the blood when it comes to the lungs, borrows oxygen from the inspired air and carries it to the different parts of the body through the circulatory system. Again the blood when it comes to the lungs is full of carbon dioxide collected from the tissues all over the body. It is a waste product resulting from the working of the bodily machine. If this gas is allowed to remain in the system, it would poison the body in a short time. Hence it has to be got rid of. The inspired air is poorer in carbon dioxide. Hence it is willing to borrow the same from the blood and take it away with expiration.

We now understand why we breathe. We breathe in order to absorb oxygen and to throw away carbon dioxide, both the processes being absolutely essential for the life of a human being.

The venous blood when it absorbs oxygen and gets rid of carbon dioxide, is said to be *arterialized*. Venous blood is first collected in the heart and thence is pushed into the lungs. There it is arterialized and again sent back to the heart to be distributed to the different parts of the body and to be returned again to the heart as venous blood.[1]

The venous blood is purple because of carbon dioxide and the arterialized blood is bright scarlet because of its oxygen. This can be proved by experimentation. If a quantity of the venous blood is put into a bottle containing oxygen and shaken, it will turn bright scarlet. On the contrary if the arterial blood is put into a bottle containing carbon dioxide and shaken, it will turn purple.

We undertook to revert to the nervous machanism of respiration at the end of this note. What we now want to say is this.

1 Our readers are requested to study carefully our note on the circulatory system given in Vol. I, No. 4. It appears there under the heading 'A Few Facts About the Blood and Blood Circulation.'

The quantity of oxygen and of carbon dioxide present in the blood, has been discovered to have great influence upon the respiratory centre. If the quantity of carbon dioxide present in the blood goes beyond its normal measure, the respiratory centre at once becomes more active; and respirations become rapid. This is best seen when a man is taking hard muscular exercise. On the contrary the centre is calmed down if the quantity of oxygen present in the blood exceeds its normal measure with the result that respiration becomes slower than usual.

The foregoing information is sufficient for a general understanding of the structure and functions of the respiratory system. Details will be supplied when we come to discuss the researches bearing on them.

N.B.—In this note we have very nearly followed the physiological theories of the Western scientists. It is possible to throw a flood of new light on many points concerning the respiratory system, by subjecting Prāṇāyāmic exercises to laboratory tests. Our present equipment both in science apparatus and subjects is so poor, that we will not be able to make *much* headway, unless we are far more favourably placed in regard to these assets. If we are given full opportunities for this type of experimental work, we feel sure that the Yogic science will be able to make very valuable contributions to modern physiology. This is not to be taken to mean that we are not making any progress at all. What we want to convey is this. Our present research work is very very limited. The field for research is vast and our present resources are comparatively poor.

SOME PHYSIOLOGICAL ASPECTS OF MEDITATIVE POSES

In the Yoga-Mīmāṅsā we have noticed various poses up to now. They can roughly be divided into two groups. *Meditative* and *cultural.* The aim of cultural poses is to produce physiological balance in the different functions of the body, so as to give it the best organic vigour. These Āsanas involve physical movements before the final pose is assumed, and the final arrangement of the different parts of the body is such as to render meditation difficult, if not impossible. S'īrshāsana, Sarvāṅgāsana, Halāsana etc., fall under this category. The aim of the meditative poses is to offer a comfortable posture for Dhyāna etc., and they are such as can be maintained for hours without much discomfort. They do not involve any out of the many movements of the body for their performance, and are in their final stage, some variety of ordinary sitting, with a few changes introduced to make the pose more useful for meditation purposes. Up to this time we have noticed four such Asanas in this journal. They are Siddha, Padma, Svastika and Sama, the last two appearing only at the beginning of the next section. It is proposed in this short article to study a few physiological aspects of these meditative poses.

If we study these meditative poses we are at once struck by three physiological features which are so characteristic of them, and which render them so appropriate for Dhyāna, Dhāraṇā and Samādhi. These physiological features may be enumerated as under.

i Elimination of the possibility of the compression of the abdominal viscera.

ii Minimizing the production of carbon dioxide in the body, so that respiratory activity may be rendered imperceptible and may even ultimately stop.[1]

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1 This last phase has yet to be observed and studied in the laboratory. We do not propose writing anything about it in this article.

iii Getting a richer blood supply for the pelvic region so that the coccygeal and sacral nerves may be toned up.

We shall now proceed to study these features at some length.

i Every student of these meditative poses knows that keeping the spine erect is one of the most essential parts of their technique. We have seen (Vide Fig. XVII, Vol. I) that naturally the spinal column is not quite straight, but has two convenient bents in its length. So when we talk of keeping the spine erect, we only mean that no new curves are to be introduced in the spinal column. This straight spine is secured by holding the trunk and the head perpendicular to the ground. The physiological advantage of keeping the spine erect, is very often pointed out to be that it keeps the spinal cord erect and thus keeps it in its proper place and allows it to function properly. This sort of argument does not appeal to us very much for the following reasons. First of all the spinal cord will not be quite straight, but will maintain its natural curve which it has to experience owing to the curved shape of the vertebral column in which it is held. Again the anatomical provisions for the protection of the spinal cord, are so thorough that there is no possibility of any interference with its functional activity, on account of any curves that the spinal column may be made to experience. Without entering into details we might note here that the spinal cord is invested by three membranes and is surrounded by an amount of fluid, and also a considerable amount of fatty tissue that serves as a packing material. 'Thus the cord is supported in the canal by its membranes; and by means of them and of the fluid and packing of fatty tissue, it is protected from shocks and jars.' When the vertebral column undergoes curves and twists, of course within particular limits, it is this protective arrangement inside the canal that keeps the cord safe and sound. So there is no chance of any interference with the functional activity of the spinal cord, if the spine is not kept erect. In fact Yoga allows the practice of Jālandhara-Bandha even during the period of meditation, and prescribes the preformance of it during Prāṇāyāmic exercises

over a considerable length of time. Thus we see that the physiological advantage alleged to accrue from the maintenance of an erect spine, is more or less imaginary, and we have to seek the advantage elsewhere.

We are inclined to think that Yogic texts insist upon an erect posture in meditation, in order to avoid the compression of the abdominal viscera and the consequent train of diseases due to their congestion. In our article on constipation we have discussed fully the causes of that disease. Therein we have seen how weak abdominal muscles lead to constipation. Now the relaxed posture which must result from the forward bent of the spine, if it is maintained for hours every day, as it would be maintained by a serious student of meditation, renders the abdominal muscles weak by being kept in a relaxed condition habitually. This along with the compression of the abdominal organs due to the stooping posture, leads to constipation, which in its turn gives rise to a number of ailments of a more or less dangerous character. We should like to reproduce here two passages from Dr. Kellogg's *Colon Hygiene* which our readers will find interesting in this connection.

"A stooped or relaxed posture in sitting or standing tends strongly to induce constipation by weakening the abdominal muscles and causing congestion of the liver and all other abdominal organs. The viscera, over-filled with bood, and lacking the support of the abdominal muscles, become prolapsed. The colon falls with the rest; kinks are formed; the intestinal contents stagnate; the bowel becomes distended; the ileo-cecal valve becomes incompetent, infection travels up the small intestine, and a long list of ills result. The check valve action of the ileo-cecal valve is essential to the onward movement of the food residues, and therefore the crippling of this valve naturally leads to constipation.

" An erect posture secures proper exercise of the muscles of the trunk, correct breathing, normal circulation of blood in the viscera, and promotes in a high degree normal bowel movement."

"Of first importance to persons suffering from constipation is the maintenance of an erect position of the trunk. When the chest is lowered, as in sitting in a relaxed attitude, the distance between the breastbone and pelvis is diminished so that the large muscles, which form the front of abdominal wall are shortened and relaxed. In this attitude the muscles cannot be contracted sufficiently to produce the proper degree of intra-abdominal pressure. When the chest is held high, the rectus muscles are stretched and are thus able by contraction to produce the maximum effect in compressing the colon. Flat-chested persons are predisposed to constipation because of inefficient action of the abdominal muscles."

These quotations will bring home to our readers the necessity of an erect posture during meditation. And as this erect posture is secured by keeping the spine straight, Yogic texts require an erect vertebral column as a part of the technique of the meditative poses.

There is another reason also why during meditation the spine is required to be held erect. During the period of meditation, the mind must be entirely relieved of the burden of the body. That means that the body must be given a posture that would be at once easy, comfortable and balanced. Now all these virtues are secured in the meditative poses because of the erect spine, the broad triangular base prepared by the folded legs and the hands that rest either on the knees or on the feet arranged in front of the pelvis. If we exclude the horizontal position assumed by the spine when we lie down, erect position is the most comfortable that the spinal column can maintain. The horizontal position is not available for Yogic meditation, because in that position the student stands the danger of falling asleep. So erect position is the only position available for meditation. Students who practise meditation find the meditative poses extremely comfortable.

ii That the meditative poses are easy and comfortable and can be maintained for a considerable length of time, is due to the fact that they involve a very very small amount of muscular

activity. Although the muscular energy required for maintaining the meditative poses, is not so small as that spent in lying down or in sleeping, yet it can be safely maintained that out of all the poses assumed in sitting or standing, the meditative poses entail the least expenditure of muscle energy. Owing to this circumstance the production of carbon dioxide during the maintenance of the meditative poses, is also reduced to the minimum.

Now it is an acknowledged physiological fact that the activity of the lungs is proportionate to the production of carbon dioxide in the body. If large quantities of carbon dioxide are manufactured in the body, the activity of the lungs is largely increased, as when athletes are engaged in running, wrestling, rowing etc. On the contrary the movements of the lungs become very slow, if carbon dioxide is produced on a small scale in the body, as is done when persons are lying down or sleeping. Again the action of the heart keeps pace with the action of the lungs. When the action of the lungs is exaggerated, cardiac activity is also accentuated, but when the lungs move quietly, the heart also slows down. According to these physiological facts, when the production of carbon dioxide is minimized during the meditative poses, both the lungs and the heart have a tendency to slow down their speed. If these meditative poses are maintained across a considerable length of time, say even for half an hour at a stretch, the breathing becomes as shallow and the heart beats are so controlled, that all the activities of the student *appear* to have come to a standstill. Under these circumstances breathing becomes exclusively abdominal; and it is only the backward and forward movements of the abdominal muscles that reveal the working of the lungs to a careful observer. Under these circumstances the mind of the Yogic student ceases *almost entirely* to be disturbed by physical movements, voluntary and involuntary; and he finds himself free first to direct his mind inward to fathom its own mysteries, then to isolate himself even from his mental equipment and stand face to face with Reality, into which he merges at last and with which he becomes ultimately identified.

iii The third and the last physiological feature of the meditative poses, which we are going to consider here, is the circumstance

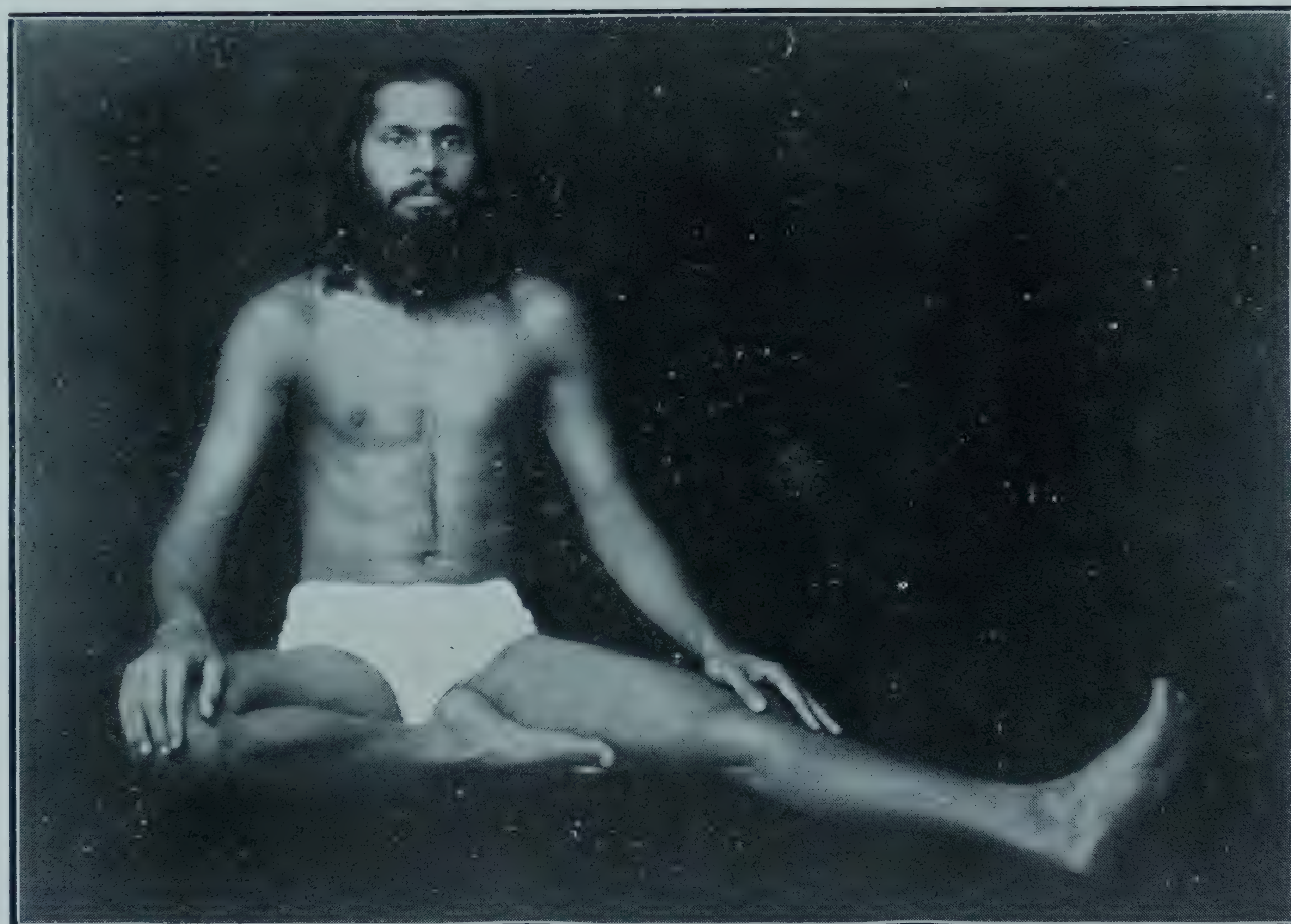
that they keep a richer blood supply playing about the pelvic region and thus tone up the coccygeal and sacral nerves. In this connection we have to what we note if brief shall say at length at the end of our article on Svastikāsana, because what is true of that Āsana in this connection, is also true of the other meditative poses referred to in the beginning of this article. In all these poses the flexors of the lower extremities are greatly contracted and pressed. The remaining muscles lie inactive accross a considerable length of time. Owing to these reasons the free current of blood circulation is interfered with. Under such circumstances, the pelvic region gets a larger blood supply from the bifurcations of the abdominal aorta. Consequently the nerves that issue from this part of the vertebral column, namely, the coccygeal and sacral nerves, get the advantage of this richer blood supply and are toned up.

How far this increased blood supply and the consequent toning up of nerves, is responsible for the awakening of Kuṇḍalinī, only experimental evidence can decide. We very much suspect, however, that the last feature of the meditative poses has considerably to do with setting up the currents of Kuṇḍalinī.

The Popular Section

The Director of the Kaivalyadhâma is ever willing to help those who are in earnest about their spiritual advancement, as he confidently feels that this help will in a way help his cause.

Fig. LX



Preparation for Svastikâsana.

SVASTIKĀSANA

or

THE AUSPICIOUS POSE

THE NAME:—

This pose is called Svastikāsana because it involves crossing of the legs which is looked upon by the Āryans as auspicious. In Saṅskṛita Svastika means auspicious. In classical Saṅskṛita the word Svastika is used even for the crossing of the hands. The reason is that the mysterious symbol Svastika is mainly represented by two lines crossing each other at right angles. Hence positions involving the crossing either of hands or of legs are also called Svastika. Fig. LXI which illustrates Svastikāsana, clearly shows how in this Āsana legs cross each other above the ankles.

THE TECHNIQUE:—

The student starts by stretching out his legs on his seat. Then he bends one of his legs, say the right, in the knee, and folds it on the thigh, just as in the case of Siddhāsana. But there is a difference in the ultimate position of the foot in this pose and in Siddhāsana. In the latter pose the heel is set against the perineum, whereas in Svastikāsana it is to be set against the opposite groin, so as to allow the corresponding sole to be in close touch with the opposite thigh. (See Fig. LX). Then without disturbing the position of the heel, the student raises the toes of his right leg with his left hand. Simultaneously he folds his left leg upon the thigh in such a way that the big toe of his right leg may project itself above the calf and the thigh between which it is held, and the left heel may be firmly set

against the right groin. The toes of the left foot are inserted between the right calf and the right thigh already folded upon each other, allowing only the big left toe to lie free. (See Fig. LXI). Needless to say that in this position the sole of the left foot stretches above the right thigh touching it closely all along. In this pose the legs should be made to cross each other just above the ankles, so that all unpleasant pressure on the bones will be avoided. When the legs are properly adjusted a sort of foot-lock is prepared which one finds very comfortable, and capable of being maintained for a considerable length of time.

The spine is to be kept erect. No attempt is, however, to be made to throw out the chest. Svastikāsana is a meditative pose and as such requires to be maintained for a long time. Any attempt to give an artificial bent to the vertebral column is likely to involve a strain.

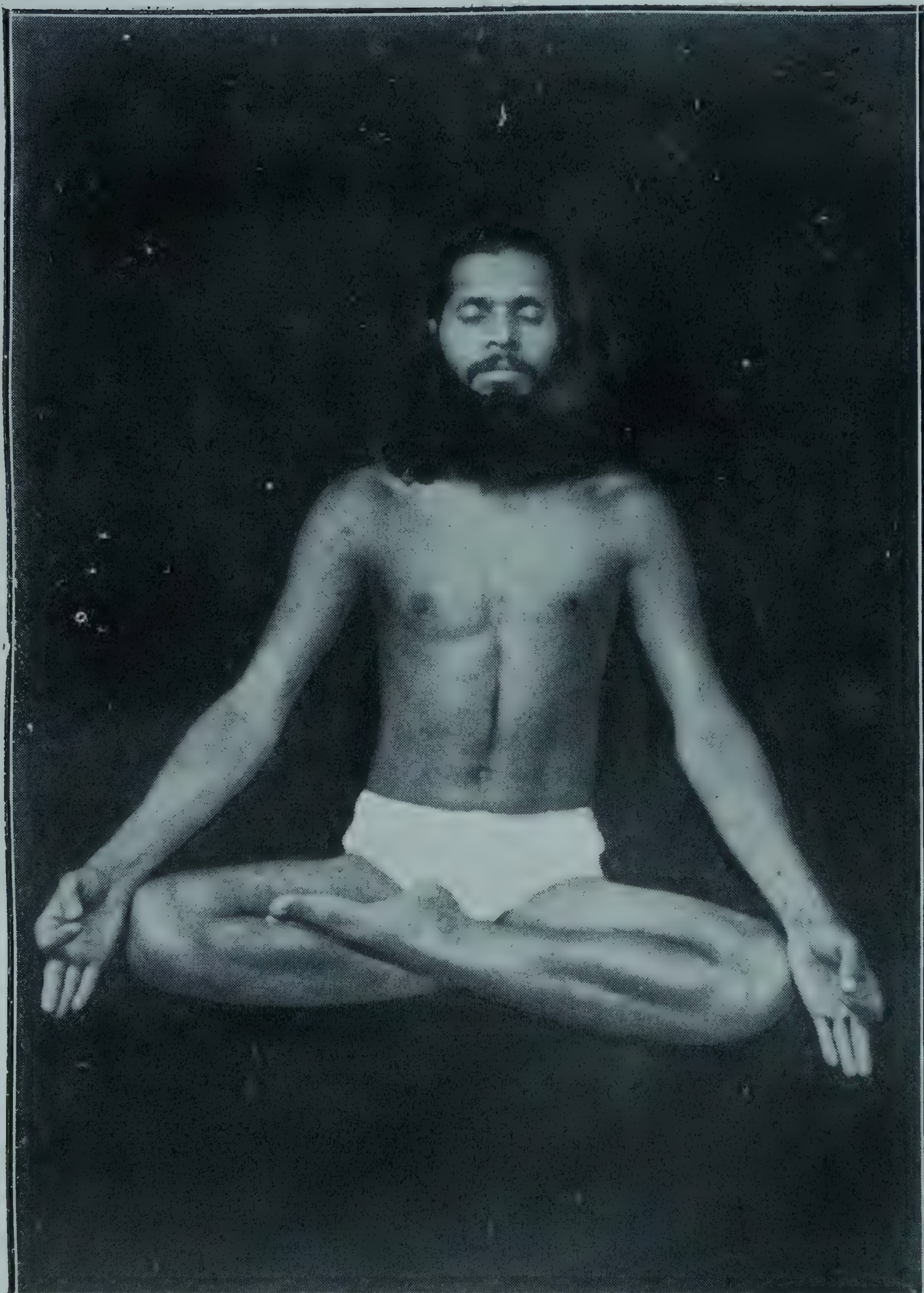
The arms may hang losely from the shoulders and rest on the knees covering them with their palms. Or they may be stretched out a little further so as to rest the wrists on the corresponding knees. In the latter case, the hands are formed into what is called Jnāna-Mudrā in Yoga. Fig. LXI illustrates the full pose.

A third way of arranging the hands is shown in Padmāsana, Fig. XCVII of the second volume.

Instead of starting with the right leg, the student may start with the left. He might then go through the whole technique, introducing corresponding changes throughout.

The eyes may either be closed as illustrated in the opposite picture or either the Nasal Gaze or the Frontal Gaze may be practised. (For the two gazes see respectively Figs. XCII and XCIII of the second volume.)

Fig. LXI



Svastikâsana or The Auspicious Pose.

POINTS OF STUDY :—

(a) *Muscles :—*

All over the lower extremities, the flexors are greatly contracted and pressed.

(b) *Blood-vessels :—*

This circumstance coupled with the passive condition of all the muscles of the lower extremities maintained for a considerably long time, interferes with the free current of blood circulation. That being the case, the pelvic region gets a larger blood supply from the bifurcations of the abdominal aorta.

(c) *Nerves :—*

The larger blood supply mentioned above tones up the coccygeal and sacral nerves.

SAMĀSANA

or

THE SYMMETRICAL POSE

THE NAME:—

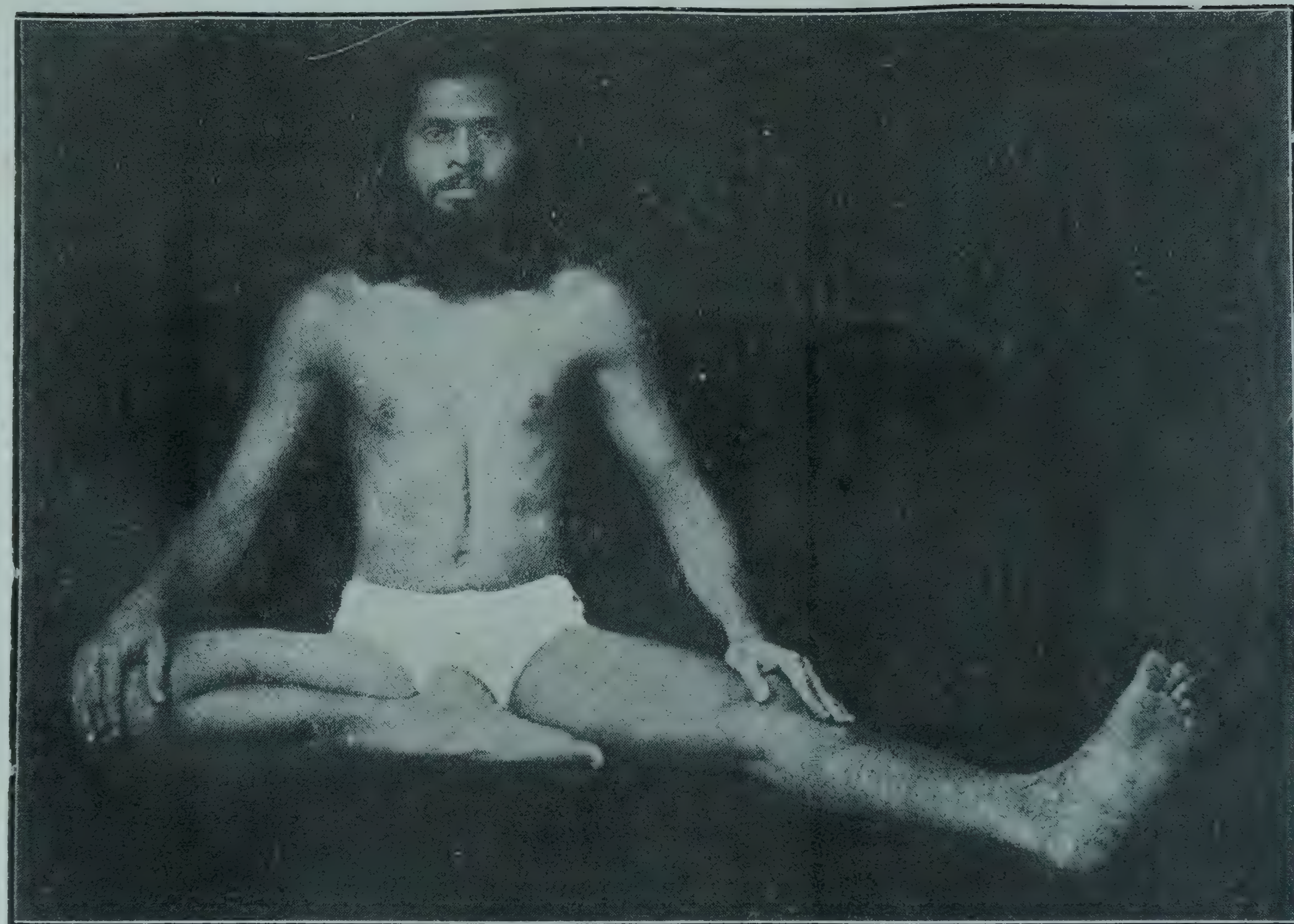
This pose is called Samāsana because in its performance all the parts of the human body are symmetrically arranged and a perfect balance is maintained. In Saṅskṛita Sama means symmetrical.

Guptāsana is another name given to this pose. In Saṅskṛita Gupta means either well protected or secret. The pose looks to be called Guptāsana because in executing it, genitals are well protected under the heels of man. Or it may be that the Āsana was practised secretly by a particular school of Yogins and continued to be their secret possession, till it became known to others and hence acquired this name.

THE TECHNIQUE:—

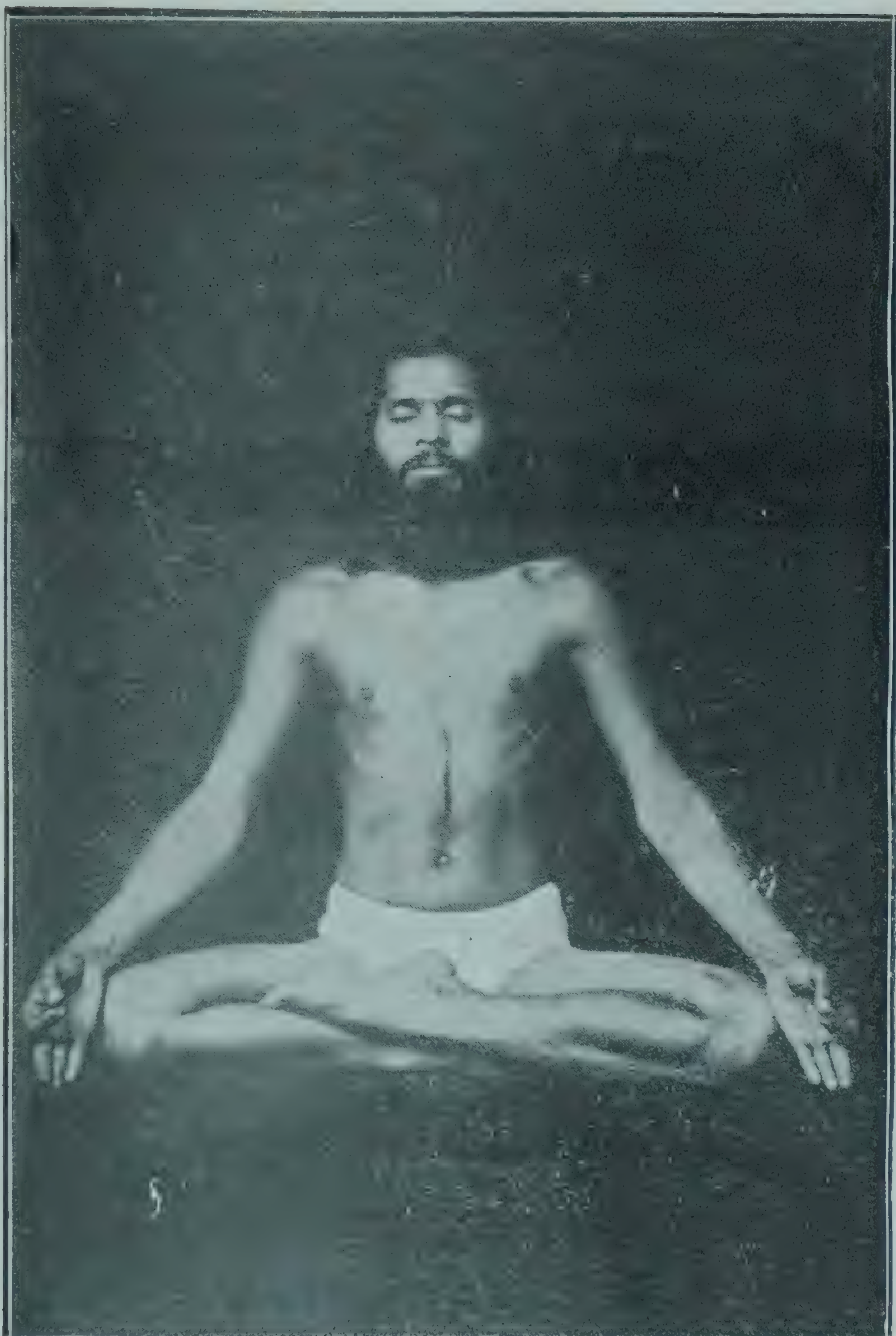
The only difference in the technique of this Āsana and the previous one, lies in the arrangement of the heels. In Svastikāsana the right heel is pressed against the groin and also the left. But in Samāsana the right and the left heels are to be set against the pubic bone, that is, the bone just above the penis. This is done as follows. While the right leg is being folded on the corresponding thigh, the student holds the heel in his right hand and the toes in his left. Then he turns the heel upward and the toes downward, and arranges the foot in his front in such a way that the heel presses against the pubic bone, the sole is turned up, and the upper surface of the foot touches the ground. (See Fig. LXII). Care must

Fig. LXII



Preparation for Samâsana.

Fig. LXIII



Samâsana or The Symmetrical Pose.

be taken at this time to see that the genitals are placed below the heel in such a way that no pressure is exerted on the testis. The other leg is similarly folded, and the other heel is placed upon the first heel, pressing against the pubic bone. The toes of the other leg are to be inserted between the calf and thigh of the first leg. (Vide Fig. LXIII).

The arrangement of the hands and eyes in this Āsana admits of as many varieties as in the previous Āsana. The spine is to stand erect and the whole body to be kept in balance.

POINTS OF STUDY:—

So far as could be observed up to now from the physiological point of view, Samāsana seems to have the same effect upon the muscles, blood-vessels and nerves as Svastikāsana.

NOTE—

As in this pose the space below the heels is just sufficient to accommodate genitals of the normal size, persons who are suffering from hydrocele etc., should not attempt this Āsana.

PRĀṆĀYĀMA

INTRODUCTION

The course of Yogic study is divided into eight parts. Āsana constitutes the third part. We have noticed the most important of these Āsanas in the pages of this journal up to now, the meditative as well as others. A student of Yoga passes on to Prāṇāyāma after mastering Āsana. In the present article we propose to treat this fourth item of the Yogic curriculum. First we shall give a general idea about Prāṇāyāma and then discuss a few technicalities common to all the varieties of Prāṇāyāma.

MEANING OF PRĀṆĀYĀMĀ

Prāṇāyāma means a pause in the movement of breath. In Sanskrita Prāṇa means breath and Āyāma means a pause. In modern literature on Yoga, Prāṇa, even in the compound Prāṇāyāma, has been often interpreted to mean a *subtle psychic force* or a *subtle cosmic element.* We do not think that the original Sanskrita text of Bhagavāna Patan'jali's *Yoga-Sūtras* any way warrants this interpretation. In these Sūtras the word Prāṇa occurs by itself only once[2] and the wording of the Sūtra is so

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1 In the language of the later Yogic literature Prâṇâyâma is called Kumbhaka. It is interesting to note here that Patan'jali does not use the words Rechaka (Exhalation), Kumbhaka (Pause) and Pûraka (Inhalation), anywhere in his Sûtras, although he does refer to these actions. His oldest commentator Vyâsa, who lived in the first century, also does not use the terms Rechaka, Kumbhaka and Pûraka. This circumstance clearly shows that this nomenclature was introduced at a later date. Tracing the history of the development, of not only these terms but many others used in the Yoga Śâstra, would be a fruitful research problem for a student of Yogic literature.

2 प्रच्छर्दनविधारणाभ्यां वा प्राणस्य । P. Y. S. I 34.

Bhagavâna Patan'jali is discussing the different means of bringing the mind under control. He has suggested various measures and one of them is contained in this Sûtra. The word Prachhardana would always mean *expulsion* and must in this Sûtra refer to breath and not to any subtle psychic force or cosmic element. Vidhâraṇa means retention. When all the three words Prachhardana, Vidhâraṇa and Prâṇa are taken together, they irresistibly drive us to the conclusion that the word Prâṇa here refers to breath and breath alone. The Sûtra means that an alternative measure for controlling the mind, is available in the alternate expulsion and retention of breath. This is not the place for discussing the question as to whether this Sûtra refers to a particular type of Prâṇâyâma or to Prâṇâyâma in general.

Vyâsa and other commentators have explained Prâṇa occuring in this Sûtra as कौष्ठ्यो वायुः meaning *air from the chest* and thus have left no ambiguity in the interpretation of the word.

clear that by no stretch of imagination can the word Prāṇa there be taken to refer to anything except *breath.* In addition to this the word Prāṇa occurs twice in the Sūtras,[1] every time being compounded with the word Āyāma. Here again the wording of the original author, Patan'jali, is very clear. He positively refers to respiratory movements. The most important commentators of Patan'jali's Sūtras have invariably explained Prāṇa to mean breath, in their commentaries on the three Sūtras referred to above.

We definitely know that authors of Haṭha texts very often use the word Prāṇa to indicate a subtle psychic force. But this they do when they talk of the force awakened by the process of Prāṇāyāma and not of Prāṇāyāma itself. Even with these authors of Haṭha, the word Prāṇa as it occurs in the compound Prāṇāy ma has only one meaning and it is *breath.* So our conclusion is that in Yogic literature Prāṇāyāma means only a pause in the movement of breath.

PATAN'JALI'S FOUR TYPES OF PRĀṆĀYĀMA

Bhagavāna Patan'jali notices four types of Prāṇāyāma, the distinction being based upon the nature of the pause. For instance when the pause is made after a thorough exhalation that would constitute the first type of Prāṇāyāma. The second type of Prāṇāyāma would be available when the pause comes after a deep inhalation. In both these cases the Yogic student is required to make a special effort for holding his breath either in or out. But in the third and fourth types of Prāṇāyāma the student is not required to make any special effort to hold his

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1 यमनियमासनप्राणायामप्रत्याहारधारणाध्यानसमाधयोऽष्टावङ्गानि । P. Y. S. II 29.
This is the first of the two Sûtras. It lays down the eight successive items of the Yogic curriculum, having Prâṇâyâma as the fourth in order. Then follows the second Sûtra to define the word Prâṇâyâma.

तस्मिन्सति श्वासप्रश्वासयोर्गतिविच्छेदः प्राणायामः । P. Y. S. II 49.
Here the words S'vâsa and Pras'vâsa which can never mean anything else than the air flowing in and flowing out, make the meaning absolutely clear. गतिविच्छेदः is a pause in the movement. Thus we see that the word Prâṇa occuring in the technical word Prâṇâyâma, according to Patan'jali and his commentators, means breath and breath alone. It never indicates any psychic force or cosmic element.

breath. The respiratory movement may stop all at once, when the student wants it to stop, the pause being continued over a considerable time without any physical effort on the part of the student. This constitutes the third type of Prāṇāyāma. The fourth type is similar to the third. The only difference between the third and the fourth types, is that in the third the pause comes all at once, whereas in the fourth a similar pause is brought about by many inhalations and exhalations preceding it. The absence of effort in maintaining the pause is common to both, the third and the fourth types of Prāṇāyāma.[1]

In the language of the later Yogic literature, the first type of Prāṇāyāma is called *Bāhya*[2] *Kumbhaka*, the second type *Abhyantara*[2] *Kumbhaka*, and the third and fourth types are called *Kevala*[3] *Kumbhakas*.

SVĀTMĀRĀMA'S EIGHT VARIETIES OF PRĀṆĀYĀMA

Svātmārāma Sūri, the author of Haṭha-Pradīpikā, the most authoritative text-book of Haṭha Yoga, mentions eight[4] varieties of Kumbhaka which is with him another name for Prāṇāyāma. It is interesting to note that the principle of division followed by Svātmārāma in distinguishing his Kumbhakas, is different from the principle adopted by Patan'jali. We have seen that Bhagavāna Patan'jali distinguished the different Prāṇāyāmas, according to the

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1 In stating this fourfold distinction of Prâṇâyâma according to Patan'jali, we have followed his commentators. We ourselves have a different interpretation for the Sûtras concerned. We shall discuss this interpretation in the pages of this journal on some other occasion.

2 The words Bâhya and Âbhyantara alone are used by Patan'jali.

3 Some idea of Kevala Kumbhaka can be had from what is known to modern physiology as ***apnea***, provided it is prolonged. Apnea is defined as a transient cessation of respiration from an overabundance of oxygen as for example, after forcible respiration.

NOTE—Hereby we do not at all want to suggest that Kevala Kumbhaka is only a prolonged apnea. Although we know what Kevala Kumbhaka is in practice, we have not yet tried any experiments with it for understanding its physiology. And having pledged ourselves to a strictly scientific policy, we cannot make any statement that is not backed up by laboratory evidence. The physiological apnea has been stated here only to convey an idea as to what a Kevala Kumbhaka is like.

4 सूर्यभेदन, उज्जायी, सीत्कारी, शीतली, भस्त्रिका, भ्रामरी, मूर्च्छा and प्लाविनी are the eight varieties of Kumbhaka. Of these we are going to notice Ujjâyî in this issue. Why we prefer Ujjâyî to other Kumbhakas here, is explained in the body of this article.

nature of Kumbhaka itself. But Svātmārāma Sūri tries to make a distinction between a Kumbhaka and a Kumbhaka, not because the nature of the Kumbhakas themselves is different, but because the nature of the inhalations and exhalations between which these Kumbhakas occur, is different. Thus the technique of all the eight Kumbhakas is the same. But the technique of the inhalations and exhalations differs in every case. These differences we shall notice when we proceed to study the various Kumbhakas.

DIFFERENT UNITS FOR MEASURING PRĀṆĀYĀMA & THE RELATIVE MEASURES OF ITS COMPONENT PARTS

Each round of Prāṇāyāma is generally[1] a complex act and consists of *Pūraka* (Inhalation), *Kumbhaka* (Pause) and *Rechaka* (Exhalation). We want to see what units are prescribed for measuring these parts and what relative measures we should maintain among these component parts of a complex Prāṇāyāma. But before we do so we wish to touch one more point in brief. It has already been noticed in one of the foregoing foot-notes that neither Patan'jali nor Vyāsa uses the words, Pūraka, Rechaka and Kumbhaka. So we should try here to see what terminology they used instead.

It has already been made clear that Prāṇāyāma is the technical word for Kumbhaka, both with Patan'jali as well as Vyāsa. Patan'jali also uses the word Vidhāraṇa[2] for Kumbhaka. Prachhardana which occurs in the same Sūtra as Vidhāraṇa is clearly Patan'jali's word for Rechaka. It is explained by Vyāsa as the forcible expulsion of the air from the chest.

Now the question is what word is used by Bhagavāna Patan'jali for Pūraka. So far as we understand the text of his Sūtras, we are afraid, we do not come across any word for Pūraka in his work. We know the words S'vāsa and Pras'vāsa used by him in his definition of Prāṇāyāma.[3] But we feel sure that

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1 We have used the word *generally* because in Kevala Kumbhaka, there is neither Pûraka nor Rechaka.

2 प्रच्छर्द्दनविधारणाभ्यां वा प्राणस्य । P. Y. S. I 34, where Vyâsa explains Vidhâraṇa by the word Prâṇâyâma.

3 See foot-note 1, P. 259.

Patan'jali uses these words for the *air* flowing into the lungs and the *air* flowing out of them respectively. Pūraka is a process and not the *air* being inhaled. So we want a word in antithesis to Prachhardana or Rechaka, which would denote the process. That word we do not find in the text of the Sūtras.[1] We should not be understood to mean that Patan'jali does not recognize the Pūraka action. That action he does recognize when he refers to Ābhyantara Prāṇāyāma which must be preceded by Pūraka. Our contention is that in the text of the Sūtras itself, there is no word explicitly denoting the process of Pūraka.

So we find that Patan'jali's word for Kumbhaka is either Prāṇāyāma or Vidhāraṇa and for Rechaka his word is Prachhardana. Patan'jali does not use any word for the process of Pūraka.

Next we go to the units laid down for measuring Kumbhaka, Rechaka and Pūraka. The Yogins of old were very particular about the mathematical accuracy of their processes. They were anxious to measure everything precisely in terms of time-units and space-units. We must remember that these seers had neither clocks nor any other instruments that would measure accurately very small fractions of time. So they had to depend upon time-units determined by some physical action. Each time-unit was called a *Mātrā.* The following physical actions were singled out to denote a time-unit or Mātrā—

i The twinkling of an eye.
ii Time taken to pronounce a short vowel.

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1 We know the extreme elasticity of the rules of interpretation of Saṅskṛita texts. We are sure that a Paṇdita versed in logic and rhetorics will successfully prove that S'vâsa occuring in the Sûtra तस्मिन्सति श्वासप्रश्वासयोर्गतिविच्छेदः प्राणायामः । means Pûraka. But we are not sure whether he will be able to explain *consistently* all the Sûtras of Patan'jali bearing on Prâṇâyâma, from a *practical point of view*, and yet will interpret S'vâsa as the *process of Pûraka.*

The question we are discussing here is very complicated. It is rendered more complicated by the successive commentators who were anxious to find *up to date* information in the Sûtras of Patan'jali. Our attitude is to make the Sûtras consistent in themselves, irrespective of the later developments of Yogic exercises and Yogic terminology. We do not think that Patan'jali would be condemned as a writer of an incomplete Yogic text, simply because he does not refer expressly to the different types of Prâṇâyâma described by later writers on Yoga. We shall discuss the whole problem in a separate article in this journal in some future issue.

iii Time necessary for touching one's knee thrice followed by a clap.

iv Time occupied by one normal respiration.

v Time taken up in pronouncing the sacred syllable ॐ.

Etc., etc.

Our readers will immediately see that this sort of calculation is very vague. Nor do the units agree mutually. Not that the ancient seers were unmindful of this fact. The very attempt to introduce *different* standards for determining the time-unit, shows that none of them was found to be quite satisfactory. But it has to be remembered that the practice of Prāṇāyāma was taught by the master to his pupil in person. So whatever the length of the time-unit accepted by a particular school of Yogins, the student could learn to note it accurately from his master. Moreover at the time of practising Prāṇāyāma, one has after all to *judge* the Mātrā, that is, has to determine it by a mental process. So there was no difficulty in teaching accurately the length of time that constituted a Mātrā; of course in each case as much accuracy would be ensured as was available by *judging* the time. To-day a practical student of Yoga need not worry himself over the diversity of these time-units. He should cultivate the habit of counting one, two, three...... at the interval of a second. A few minutes' practice in consultation with his watch, will make him perfect. Those that so wish it, should prefix ॐ to each number. ॐ one, ॐ two, ॐ three and so on.

Next we come to space-unit. This was necessary for measuring the force with which the inhalations and exhalations were practised. In a forced exhalation the current of the expired air can be felt up to a particular distance from the end of the nose. The more forcible the exhalation, the greater will be the space across which the flow can be detected. Very light organic fibres were suggested to be used for detecting this current. The affected space was measured in fingers etc. So the length of the air current determined the degree of pressure with which one was exhaling in Rechaka.

The way of determining the strength of Pūraka as described by the commentators of the original Sūtras, is somewhat difficult to understand. The measure of the strength of Pūraka must naturally lie along the inward flow of the inspired air. In our humble opinion the sensations which have been described as marking the space-unit of P raka are extremely vague and may not give even a tolerably accurate idea even to an advanced student of Yoga. So we do not attempt any description of this space-unit here.[1]

For all practical purposes, spiritual as well as physical, the following hints will suffice.

i The length of time to be given to Pūraka should be half of what is being given to Rechaka.[2]

ii Throughout Pūrakā, the inhalation should be uniform.[3] That is the strength of the flow should be of

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1 We hope to take up this subject again and discuss at some length the space-unit of the commentators.

2 We shall state later on what time should be given to Rechaka.

3 Either in the case of Pûraka or in the case of Rechaka if the time-unit is taken care of, and a uniform flow of breath is secured, the space-unit takes care of itself. We shall explain how.

At a particular stage of development a student of Yoga is able to inhale a particular quantity of air and exhale a similar quantity. The measure of this air, as we have shown in our note on respiration, determines the vital capacity of the individual. Let us suppose that the student is able to inhale 3500 c.c. and exhale as many. Now if the inhalation is uniform, and occupies, say, ten seconds, roughly speaking, some 350 c.c. of air will flow in every second. But if the inhalation were to take seven seconds instead of ten, some 500 c.c. will be drawn in per second. It can be easily seen that the force required for drawing in 500 c.c. must be greater than the force required to draw in 350 c.c., if the work is to be done within the same length of time. Again if the inhalation were to require fourteen seconds, the quantity of air inspired per second would be 250 c.c. only. Hence the force necessary for this work will be less than that required in the ten seconds' Pûraka. So the force required to be exerted in seven seconds', ten seconds' and fourteen seconds' inhalations, varies inversely as the length of time occupied by the inhalation. The shorter the time of inhalation, the greater will be the force required to carry out the action. Thus the force and the length of time being inversely proportionate, we can regulate the force by regulating the time. And once the force is determined, the space-unit is also determined. Hence if we take care of the time-unit and ensure a uniform flow, the space-unit will take care of itself. What has been said here of Pûraka, applies to Rechaka also.

This explanation of ours is likely to make our readers curious as to why Bhagavâna Patan'jali should have introduced both the space-unit as well as the time-unit in measuring his Prâṇâyâma. We have an explanation for this also, but we cannot give it here for want of space. We shall tender it to our readers on some future occasion.

the same degree throughout. The act should neither be slowed down nor hurried up.

iii Every Pūraka must end quietly. Many people are in the habit of contracting most violently muscles of the whole body at this stage. It is to be noted that no amount of violence done to muscles other than respiratory, will enable a person to draw in even one additional c.c. of air.

The time-unit is applicable even to Kumbhaka. The practical method of measuring the length of time occupied by Pūraka and Rechaka that we have described above, should also be used for Kumbhaka.

Having studied the Mātrās by which we can measure Pūraka, Kumbhaka and Rechaka independent of one another, we now proceed to see what relation these three component parts of Prāṇāyāma should bear among themselves so far as their duration is concerned. In this connection the most favoured view is to have the durations of Pūraka, Kumbhaka and Rechaka in the proportion of 1 : 4 : 2. According to another tradition, this proportion should be 1 : 2 : 2. Thus if Pūraka consists of sixteen Mātrās, Kumbhaka should be of sixty-four and Rechaka of thirty-two Mātrās, according to the first proportion. And according to the second proportion for sixteen Mātrās of Pūraka, both Kumbhaka and Rechaka should have thirty-two each. There is a third tradition which lays down the same measure for all the three parts of Prāṇāyāma.

This is all right so far as the *relative* durations of Pūraka, Kumbhaka and Rechaka are concerned. But what should be the absolute durations of Pūraka or Kumbhaka or Rechaka, one of which being fixed, would fix up the other two. Here the safest course would be first to settle the Mātrās of Kumbhaka and then to follow any of the proportions stated in the foregoing paragraph. Individually we are in favour of the second proportion for a beginner, although an advanced student can follow the first proportion without any danger to himself. Again in fixing up the Mātrās of Kumbhaka, a beginner should see that he can hold

his breath very comfortably during the whole duration. Not only this but he should also see that he is able to perform Rechaka in due proportion with an equal degree of comfort. The whole practice of Prāṇāyāma should be gone through with utmost ease and comfort. No jerks, no violence, no undue sense of suffocation should be there at any stage of Prāṇāyāma.

We very strongly advise the beginners to start only with Pūraka and Rechaka, their respective durations being in the proportion of 1 : 2. The physical culturist can get all the advantages he wants to derive from Prāṇāyāma, by the practice of Pūraka and Rechaka only.[1] *Even a spiritual culturist can make a good deal of progress without the practice of Kumbhaka.*[2] *So there should be absolutely no hurry about taking to Kumbhaka. So also when Kumbhaka is started, it should be very slowly and cautiously developed. Kumbhaka is the one thing in Prāṇāyāma which demands the utmost attention on the part of a student of Yoga. If, however, it is developed with due caution and care, there is nothing dangerous about it or about Prāṇāyāma as a whole.*

The duration in Prāṇāyāma should be judged mentally. Both the physical culturists and the spiritual culturists should practise Prāṇāyāma with utmost concentration. The mind should very closely follow the movement of breath. In numbering the Mātrās the concentration on the breath is disturbed. Again the spiritual culturist, as he advances, is required to concentrate upon different points either inside the body or outside it. In this work the numbering of the Mātrās causes a little distraction. Those that can manage the numbering business without allowing their concentration being affected, may take to it if they so choose.

In a discussion on Prāṇāyāma a reference to Nāḍīs is absolutely necessary. Hence we proceed to a consideration of these.

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1 This statement is made after a prolonged study of facts not only in our wide curative and preventive practice of Yogic Therapy, but also after a large number of experiments in the laboratory.

2 We have a number of Sâdhakas under training with us. It has been almost invariably observed that activity in some of the most important Chakras can be *started* simply by the practice of Pûraka and Rechaka, without taking to Kumbhaka at all. Of course for further developments Kumbhaka looks to be essential.

THE NĀḌĪS

In later Yogic literature the Nāḍīs play a very important part. But either in Bhagavāna Patan'jali or in the oldest commentary on his Sūtras written by Vyāsa, the word Nāḍī occurs only once.[1] There again the reference is to a Nāḍī that is comparatively of small importance. The total number of Nāḍīs present in the human body has been variously estimated. According to one author it is 72,000, whereas according to another it is as huge as 350,000. Nāḍīs are, however, distinguished as those of comparatively small importance, those of some importance and those of greater importance. One is singled out as the most important of the whole lot. The number of Nāḍīs of some importance is stated to be either ten or fourteen. There is, however, perfect agreement among the authors of Yogic literature in mentioning the number of the more important Nāḍīs as three[2] and also that of the most important as one.[3]

Can we identify these Nāḍīs with any of the anatomical structures of the modern science? Up to now various attempts[4]

1 It is in the Sûtra कूर्मनाड्यां स्थैर्यम् । P. Y. S. III 31.

2 इडा, पिङ्गला and सुषुम्ना.

3 सुषुम्ना.

4 By far the boldest attempt in this direction has been made by Dr. V. G. Rele of Bombay in his book *The Mysterious Kundalini*. The book is certainly thought-provoking and Dr. Rele has worked hard at his thesis. He has taken full advantage of his knowledge of modern anatomy and physiology, and some of his guess-work has every chance of standing the laboratory tests. He has explored a very large field of Yogic physiology and anatomy, and every student of Yoga will ever feel indebted to him for this his labour of love. We heartily recommend the book to our readers' attention. But after all his conclusions are based upon *mere speculation*. Dr. Rele has not tried a single experiment in the laboratory, nor has he taken much care to consult the practical experience of the students of Yoga. As such, we are afraid, we cannot accept his conclusions as scientifically sound. Nay, we have serious doubts regarding the accuracy of many of his interpretations, and the whole book looks to be of doubtful scientific value. Dr. Rele very frankly admits in his preface to the book that his interpretations are 'possible suggestions only'. Another attempt in this direction that deserves special mention here, is that of the great Swâmî Vivekânanda. His lectures on Râja-Yoga are full of interpretations of Yogic things in the light of modern sciences. We are sorry to note here that the Swâmijî's attempt suffers from the same drawbacks as the work of Dr. Rele. The whole structure is based upon the treacherous sands of speculation. Being pledged to accept nothing, in the field of scientific interpretation, as sound, unless it is backed up by laboratory evidence, we cannot accept the conclusions of the great master as scientific. We do not want to be misunderstood.

have been made for such an identification, at least in the cases of the important Nāḍīs; but all of them, so far as we know, have been of a literary character. No strictly scientific effort has been made to this day. Being pledged to a policy of strict scientific accuracy, we cannot accept the results of these efforts as scientifically sound. We too have many hypothetical conclusions regarding the Yogic anatomy and physiology. But we do not wish to place them before the public *as scientific*, unless we test them in the laboratory.

For the information of our readers, however, we shall mention the modern interpretations put upon the words Nāḍī, Sushumnā, Iḍā and Piñgalā. Without going into details, we shall also broadly say whether these interpretations are acceptable to us or not. Our acceptance or otherwise has, however, absolutely no scientific value, as it is based upon mere guess-work to-day.[1]

Continued—
We make a distinction between Yoga as a reliable guide for spiritual evolution, and Yoga being scientifically interpreted. For centuries, how many we do not know, Yoga is being practised as a means to self-realization. The traditional practices are as sound as anything known to modern science. We have adamantine faith in the efficacy of these exercises as a means to spiritual evolution. But the scientific interpretations of the Yogic practices and Yogic anatomy and physiology, is quite a different thing. It means trying experiments upon these practices in the laboratory according to the strict scientific methods and basing one's conclusions on the results thus obtained. Evidently Swâmî Vivekânanda never tried these experiments and had to resort to speculation. This is a statement of facts and there is no intention to find fault with the Swâmijî. His lectures on Râja-Yoga are master-pieces of inspirational literature. We ourselves owe a deep debt of gratitude to the great master, especially as the author of his lectures on Râja-Yoga. A third attempt which compells attention is that of Dr. Brajendranath Seal. In his very valuable book, *The Positive Sciences of the Ancient Hindus*, the Doctor attempts scientific interpretations of some of the Yogic anatomical terms. Even though his interpretations are better than those of Swâmî Vivekânanda and anticipate in particular respects those of Dr. Rele, they cannot be treated as scientifically sound. They are not supported by any laboratory evidence. But the oldest attempt in the direction of scientifically interpreting the Yogic anatomy seems to have been made by Major B. D. Basu who published an article on this subject in *The Theosophist* as far back as 1888. His interpretations though speculative certainly claim great admiration. It is a pity that those who followed Major Basu did not take advantage of his precious work. It is greatly surprising to find Dr. Rele not acknowledging his debt both to Major Basu and Dr. Seal, each of whom has anticipated some of his interpretations. Perhaps he did not know their works.

1 We are trying our best to equip our laboratory with such apparatus as would enable us to conduct experiments on the Nâḍîs. Everything else is ready. And by the grace of the Lord, we feel sure we shall soon have the desired equipment also.

Nāḍīs have been identified with the nerves of modern anatomy. Although there are places in Yogic literature where the word Nāḍī has definitely been used in some other sense, this interpretation is on the whole acceptable to us. In fact the description[1] of the Nāḍīs in general given in one of the Yogic text-books, is so vivid and accurate, that there is little scope for any difference of opinion regarding the interpretation.

The same may be said about Sushumnā. It is explained as the spinal cord. We have not got *much*[2] objection to this interpretation.

Iḍā and Piñgalā are identified by Swāmī Vivekānanda[3] with the sensory and motor tracts of the spinal cord. We cannot accept this interpretation, however, as it does not tally with the description of these Nāḍīs in the original Sanskṛita texts. Dr. Rele's interpretation[3] of Iḍā and Piñgalā as the mere chains[4] of central ganglia, one on either side of the middle line of the vertebral column, is almost acceptable to us. In fact hypothetically we had come almost to this very conclusion even before Dr. Rele's book was published. Even now, however, we have some difficulties in fully accepting this identifiication of Iḍā and Piñgalā as even hypothetically final. Most probably we will have to modify it a little.

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1 नाड्यस्तु ता अधोवक्त्राः पद्मतन्तुनिभाः स्थिताः ।
पृष्ठवंशं समाश्रित्य ... ... ॥ Śiva-Samhitâ, II 17.

These Nâḍîs are like the fibres of a lotus, and being supported by the vertebral column, spread downwards.

2 We say *much* because we too think that Sushumnâ is to be identified with the spinal cord. But we are not sure as to whether it is to be identified with the entire cord or only with a part of it.

3 Thus asserts the Swâmijî in his Lectures on Raja-Yoga—

"The columns of sensory and motor fibres in the spinal cord are the Idâ and Piñgalâ of the Yogins. They are the main channels through which the afferent and efferent currents travel."

Dr. Rele in his *Mysterious Kundalini* writes—

"From this description of the Nâḍîs, Idâ and Piñgalâ, they are nothing but the gangliated cords of the sympathetic system, which we know are situated (one ?) on each side of the spinal column." P. 35.

4 For the anatomy of the nervous system see Y. M., Vol. I, p. 52.

We have thus far studied the speculative identification of the Nāḍīs. Now we go to note a few more points concerning the Nāḍīs, because they often occur in Yogic literature.

It is believed[1] that inhalation through the right nostril creates heat in the body and inhalation through the left nostril creates cold. This has most probably led Yogins to describe the right Nāḍī, that is, Piñgalā as the Sūrya-Nāḍī. Sūrya means the sun and is the symbol of heat. In the same way Idā is called the Chandra-Naḍī, Chandra, the moon, standing as a symbol of cold.

Again the word Naḍīs stands for the nostrils. Thus Sūrya-Nāḍī means either Piñgalā or the right nostril, and Chandra-Nāḍī means either Iḍā or the left nostril.

What has been said up to now is intended to get the modern student of Yoga in touch with the traditional phraseology. We have also given some hints to the practical student of Yoga. We shall make some more practical suggestions in this article before we close it.

OXYGEN VALUE VERSUS NERVE CULTURE VALUE OF PRĀṆĀYĀMA

The Westerner looks to exercises in deep breathing mainly from the point of view of its oxygen value.[2] He appreciates these exercises principally because they give him a larger quantity of oxygen to vitalize his system. With us the oxygen value of Prāṇāyāma is subordinate. We prize it more for its usefulness in nerve culture.[3] We make this statement not only for the spiritual culturist but for the physical culturist also. Let it be, however, borne in mind that even the oxygen value is not below our attention.

1 We are trying to collect laboratory evidence to test this belief; and although it is too early to say anything in the matter, we hope to find scientific support in favour of it.

2 We are conducting a number of experiments in our laboratory on the oxygen value of Prâṇâyâma. The whole material will be placed before our readers when it is ready for publication. The data being collected are likely to add to our present day knowledge of metabolism.

3 A full discussion on this very interesting but controversial point will appear in the next issue. There we shall state the scientific evidence we have at our disposal in support of the stand that we have taken.

THE PLACE

Hence whether the student takes to Yoga for spiritual culture or physical, he must practise Prāṇāyāma in a very well ventilated place. He should not allow himself, however, to be exposed to a strong draught. Practising Prāṇāyāma in the open is extremely healthy. A spiritual culturist should, however, see that he avoids all disturbing factors. In his case the need for utmost concentration is extreme. Hence it is desirable that he chooses a thoroughly ventilated room which is free from mosquitoes etc., and where he would be left to himself. Even the possibility of being disturbed, comes in the way of perfect concentration. If he could reserve a room for this work and build up a spiritual atmosphere there, it will help him a good deal in his work.

THE SEAT

For a spiritual culturist the traditional arrangement of seating is excellent. A carpet of Kus'a grass,[1] with a well tanned deer hide[2] spread on it, the hide in its turn being covered with a daily washed piece of thick khaddar, makes a very comfortable seat. The pleasures of such a seat are the peculiar privilege of those god-intoxicated aspiring souls who seek salvation through Yoga. The thrilling spiritual experiences that this seat affords to the student from day to day, make it more attractive to him than even the throne of an emperor !

A physical culturist is by no means barred from using such a seat. Even to him it will have its own attraction. But he need not be very particular about its use. He can practise his Prāṇāyāma while sitting, or while standing or even while walking.[3]

1 In the absence of a Kus'a grass carpet, any other grass carpet will do.

2 Those that may have a conscientious objection to the use of a hide, should make use of a thick woolen cloth folded over several times.

3 We cannot much appreciate the advice given to their followers by particular physical culturists, to practise Prâṇâyâma while taking violent muscular exercise. So far as we understand the physiological aspects of both Prâṇâyâma and violent muscular work, we have no hesitation in saying that it is impossible to practise Prâṇâyâma while violent muscular work is being done. One may hold his breath for a time during such a work and give it the dignified name of Prâṇâyâma or Kumbhaka; but any attempt to claim Prâṇâyâmic advantages for such a holding of breath, is as unscientific as it is misleading.

It is with the intention of giving the physical culturist an opportunity to practise Prāṇāyāma even in walking,[1] and yet not to go against the traditional rules of Prāṇāyāma, that we have arranged to give in this issue the technique of Ujjāyī. This is the only type of Prāṇāyāma allowed by the Yoga S'āstra to be practised even while one walks. It is principally for this reason that we teach Ujjāyī to every man that comes to us for Yogic instruction, be it for his body or for his mind.

THE POSTURE

If the physical culturist prefers to practise Prāṇāyāma while walking, no question of posture arises with him. Again if he chooses to have the practice of Prāṇāyāma in a standing position, the question of Āsana is of no consequence to him. He should, however, stand erect and rest his hands on his iliac bones.[2] So also if a physical culturist thinks going through the Prāṇāyāmic exercises while sitting, he should assume an erect posture[3] and rest his hands on his knees. It is not necessary for him to assume any of the Yogic postures. The spiritual culturist shall always sit in one of the meditative poses. The importance of Āsana in the process of his evolution, can never be exaggerated. As stated in our article on the meditative poses referred to in the last foot-note, the principal meditative poses are Siddha, Padma, Svastika and Sama. Of these we should specially recommend to our readers the first and the last. Both these Āsanas have a special spiritual value.

MUDRĀ

Spiritual culturists will do well to note in short the technique

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1 गच्छता तिष्ठता कार्यम् उज्जाय्याख्यं तु कुंभकम् । Haṭha-Pradîpikâ, II 52.
The Ujjâyî Prâṇâyâma may be practised even in standing or in walking.

2 The physiological significance of the technique of Prâṇâyâma will be discussed at length in the next issue. We are sorry we could not include the article in this number. Suffice it to say that every point has its own scientific importance and should be carefully attended to.

3 Our article on the meditative poses appearing in the Semi-Scientific Section of this issue, explains the hygienic value of an erect posture. The article is intended for the physical culturist as well as the spiritual culturist.

Fig. LXIV



Jnâna Mudrâ or The Symbol of Knowledge.

of what is known as Jn'āna-Mudrā, the symbol of knowledge. This Mudrā is practised as an accompaniment of a meditative pose. The palms are fully stretched out and the tip of the index finger, that is, the finger next to the thumb, is made to touch the tip of the thumb of the same hand. In this action, it is the forefinger that is bent to meet the thumb, the latter advancing a little, no doubt, to meet its fellow. Fig. LXIV illustrates this Jn'āna-Mudrā by itself, whereas Figs. LXI and LXIII illustrate the same when practised as a part of Svastikāsana and Samāsana respectively.

BANDHA

The different Bandhas, namely, Uḍḍiyāna,[1] Jālandhara[2] and Mūla,[3] that play a prominent part in the practice of Prāṇāyāma have already been described. Under no circumstances should Kumbhaka be practised without Jālandhara-Bandha. The practice of the other two Bandhas is optional.[4]

TIME

For a physical culturist any time half an hour before the meal, or four hours and a half after the meal is available.

A spiritual culturist should practise Prāṇāyāma twice a day, that is, morning and evening to begin with. As he advances he may take advantage of the midday and ultimately of midnight. Every time he must see that he has a thoroughly light stomach before he starts his Prāṇāyāma. His meals must always be moderate. One meal plan is the best for him. He must allow some six hours between his last meal and his exercises. Even after taking a moderate quantity of milk, he must not take to his practice for three hours.

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1 Vide Y. M., Vol. I, p. 9.

2 Vide Y. M., Vol. II, p. 226.

3 Vide Y. M., Vol. II, p. 225.

4 The practice of Kumbhaka with the simultaneous exercise of all the three Bandhas is *highly dangerous*, if done without proper care and caution. No student of Yoga should indulge in this exercise without the help of an expert.

In the morning the exercise of Prāṇāyāma should be tried after the cleansing processes of Dhauti, Basti etc., and even after the Āsanas. In the evening Prāṇāyāma should come after the Āsanas.[1] If any meditation is being practised, Prāṇāyāma should preceed it.

THE CONCLUSION

In concluding this short article on Prāṇāyāma, we have to point out to our reader that the subject is very vast and requires volumes of information for its full treatment. These notes are intended for enabling the reader to follow our research work intelligently, and also to help him in his Yogic practices, if he is using this journal as his text-book. Prāṇāyāma is by far the most useful exercise for a physical culturist. To the spiritual culturist its importance is supreme. We shall try our best to supply scientific information to both these classes of readers in the volumes that follow the present one.

We earnestly request our readers never to allow their enthusiasm to get the better of reason. Prāṇāyāma is a weapon that easily lends itself to abuse. In playing with Prāṇāyāma, a man plays with his nerves, heart and lungs. Undue strain or imperfect methods in Prāṇāyāma may damage these parts permanently. So everyone should proceed into this business with due caution and care. When this is done and when our instructions are attentively and faithfully followed, Prāṇāyāma is perfectly safe. When rightly done Prāṇāyāma will never fail to ensure supreme vitality for the body and eternal peace for the mind.

1 Here we have simply indicated the sequence of the different Yogic practices. We do not mean that the other practices must necessarily be gone through before one takes to Prâṇâyâma.

UJJĀYĪ PRĀṆĀYĀMA

THE NAME :-

We have already explained the meaning of the word Prāṇāyāma, in our article on this subject appearing in this very Section. It has also been stated there that the author of Haṭha-Pradīpikā gives eight varieties of Prāṇāyāma, one of which is Ujjāyī. We do not definitely know why this particular type of Prāṇāyāma is called Ujjāyī. We may, however, venture two conjectures about this name. In ancient India greetings consisted of the word Jaya which was always loudly pronounced. Hence the word Jaya and the cognate words came to be closely associated with loud pronounciation. Now the chief characteristic of the Ujjāyī Prāṇāyāma is the loud noise produced, as will be seen in the technique, by a partial closure of the glottis. Hence it is *possible* that this Prāṇāyāma is called Ujjāyī to distinguish it from other varieties. This conjecture of ours is rendered *probable*, when we take into consideration the following two facts. (1) The prefix Ud occuring in the name Ujjāyī (उद् + जायी), means *aloud.* (2) Ujjāpī, a varient reading noticed by Brahmānanda, in his commentary on Haṭha-Pradīpikā, actually means *pronounced loudly.* Most probably the varient Ujjāpī was suggested because the original word Ujjāyī was not so clear in its meaning. So in all probability Ujjāyī also means *pronounced loudly.*

There is some possibility of the Prāṇāyāma being called Ujjāyī because its practice was supposed to lead one to success. Ujjāyī might be interpreted to mean *leading to success.*

THE TECHNIQUE :-[1]

1 Our readers are requested to master our 'Note on Respiration' before trying to practise Ujjâyî according to the technique given here. The technique given here is intended for enabling the reader to pick up the practice The scientific side of this technique will be discussed in a separate article in the next issue. Nearly every point in the technique has a scientific explanation in its support.

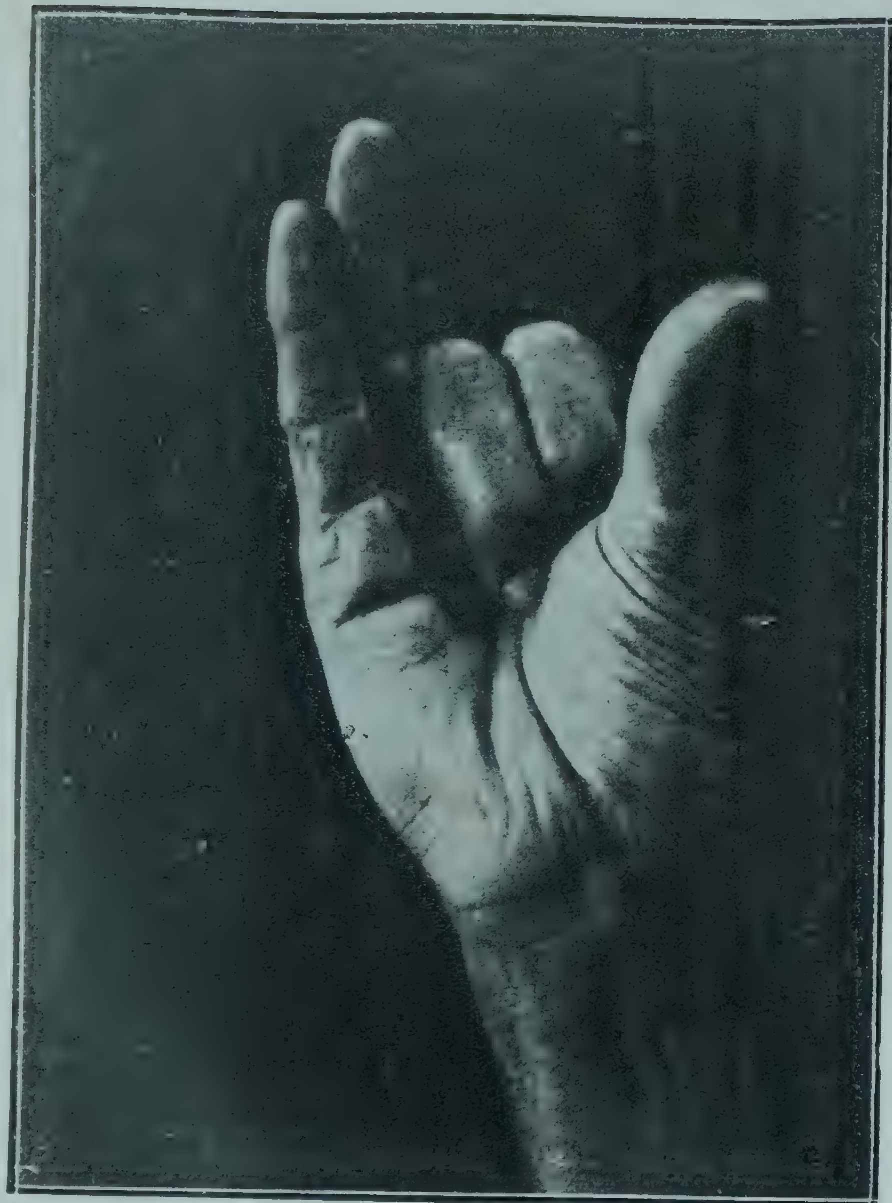
The general instructions regarding the time, the place, the seat, the posture etc., given in the article on Prāṇāyāma in this issue, are all applicable to Ujjāyī. We shall now give the particular technique of this Prāṇāyāma.

PŪRAKA :-

Before we describe the technique of Pūraka in Ujjāyī, we wish to refer to a point in the technique of Prāṇāyāma in general, so far as the inhalation and exhalation are concerned.

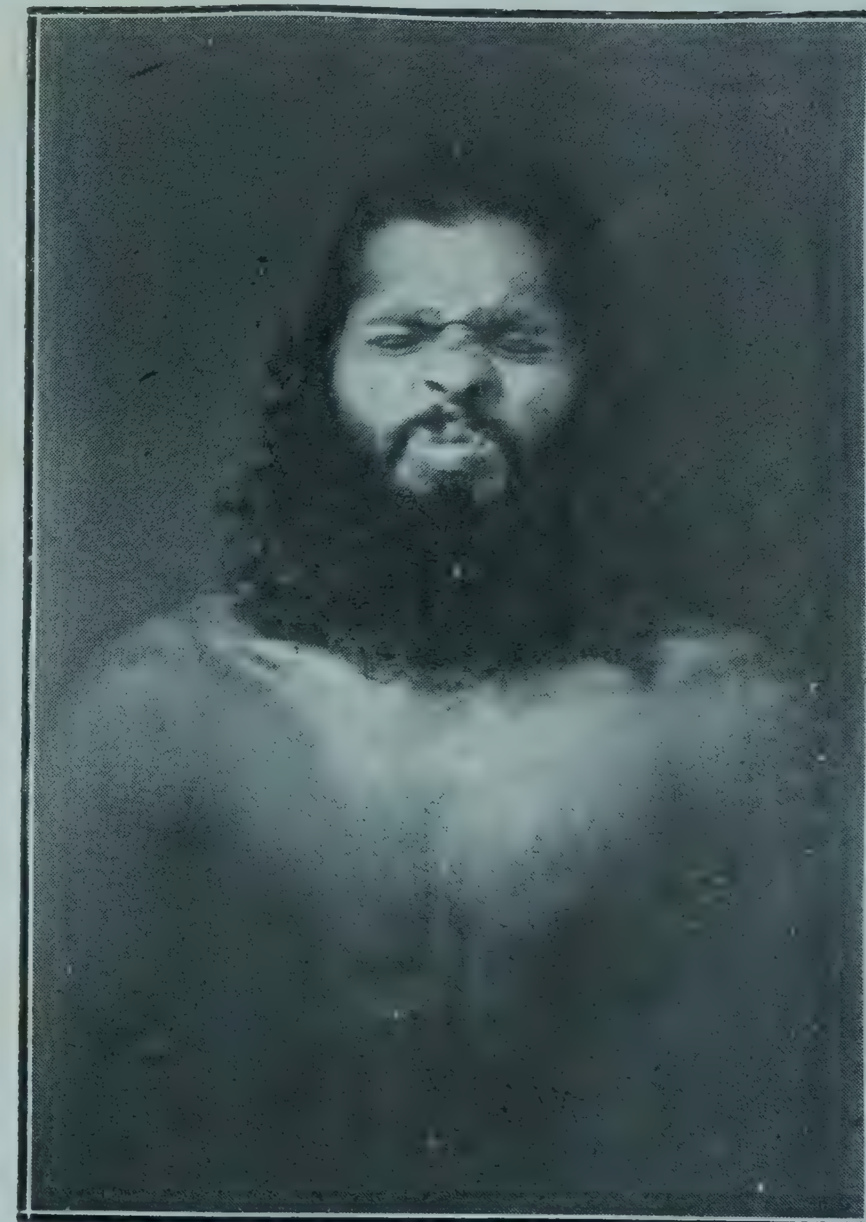
Generally speaking during the course of Prāṇāyāma one is required to keep closed one nostril or the other, and in every Kumbhaka both the nostrils. What is the orthodox way of closing the nostrils in Yoga? Tradition requires this work to be done in a particular manner. According to our view which we will give in the next issue, this manner of closing the nostrils is not only very comfortable but it is also scientific. The right palm is spread out. The index and the middle fingers are turned down, the other two fingers and the thumb remain extended. (Vide Fig. LXV). Now the thumb and the extended fingers are placed on the bridge of the nose, the thumb on the right side of it, and the fingers on the left. Then if the right nostril is to be closed, the fingers are allowed to retain their position; but the thumb is slided downwards, and made to sit tight upon the elastic right nostril, pressing it against the septum at the side and the hard bone above. (Vide Fig. LXVII). Again if the left nostril is to be closed, the thumb is taken back to its original position on the bridge of the nose; and the fingers are slided down to sit tightly upon the left nostril, pressing the elastic part against the septum at the side and the nasal bone above. (See Fig. LXVIII) If both the nostrils are to be closed, both the thumb and the fingers are slided down, pressing against the nostrils as in the last

Fig. LXV



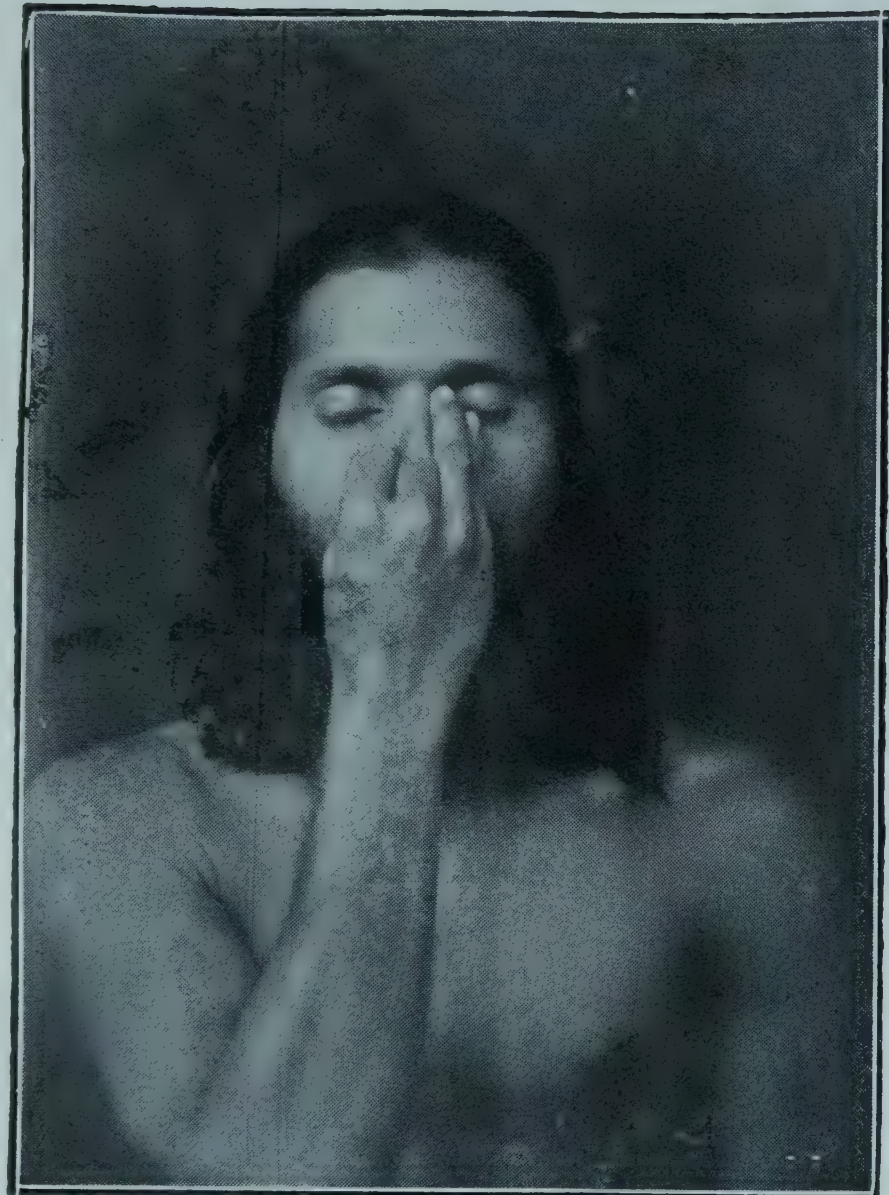
Preparation for Closing the Nostrils.

Fig. LXVI



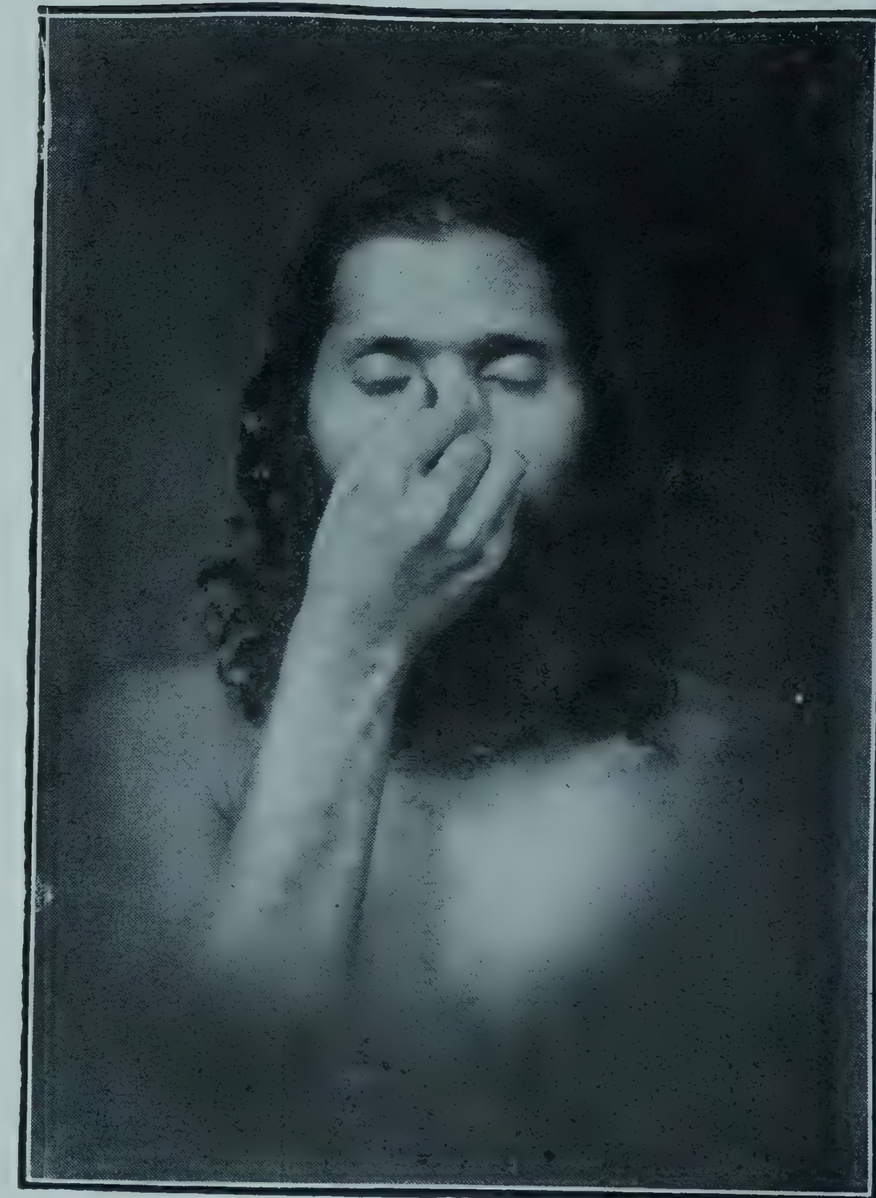
Ugly Contortions of the Face.

Fig. LXVII



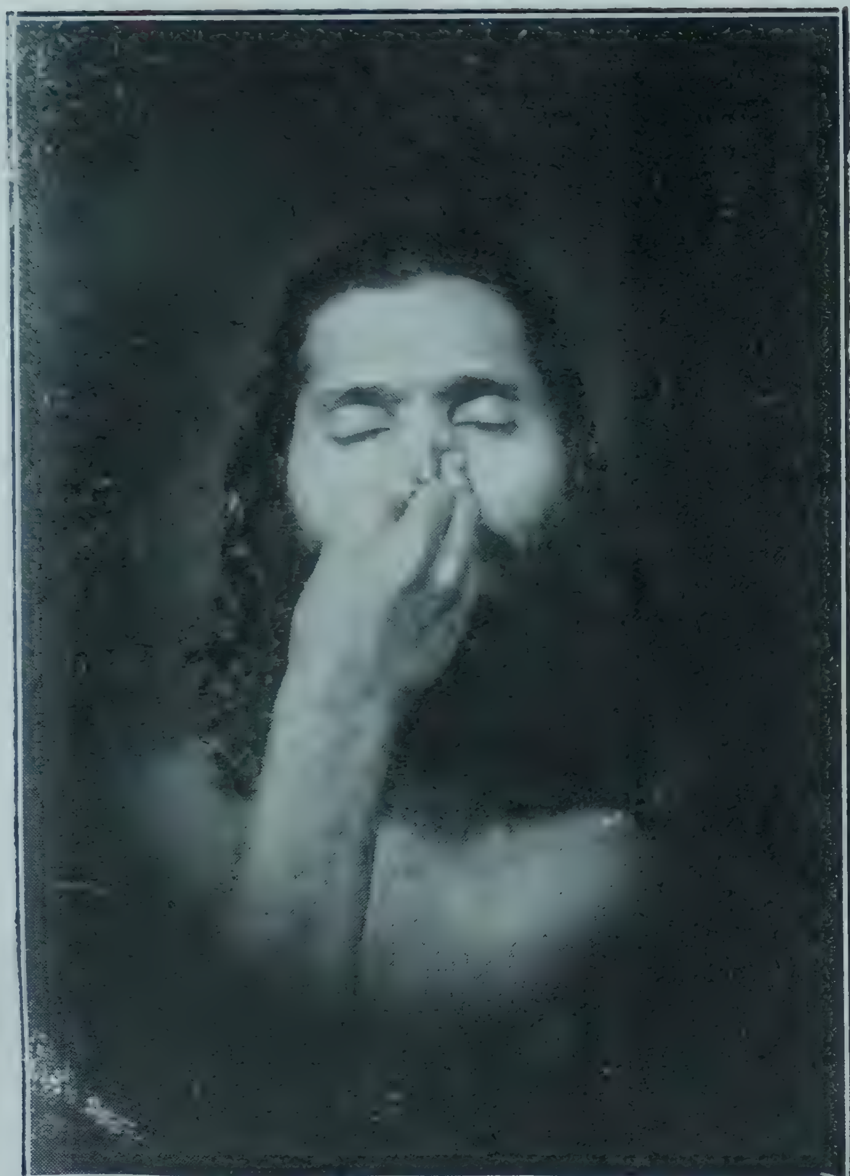
The Right Nostril Closed.

Fig. LXVIII



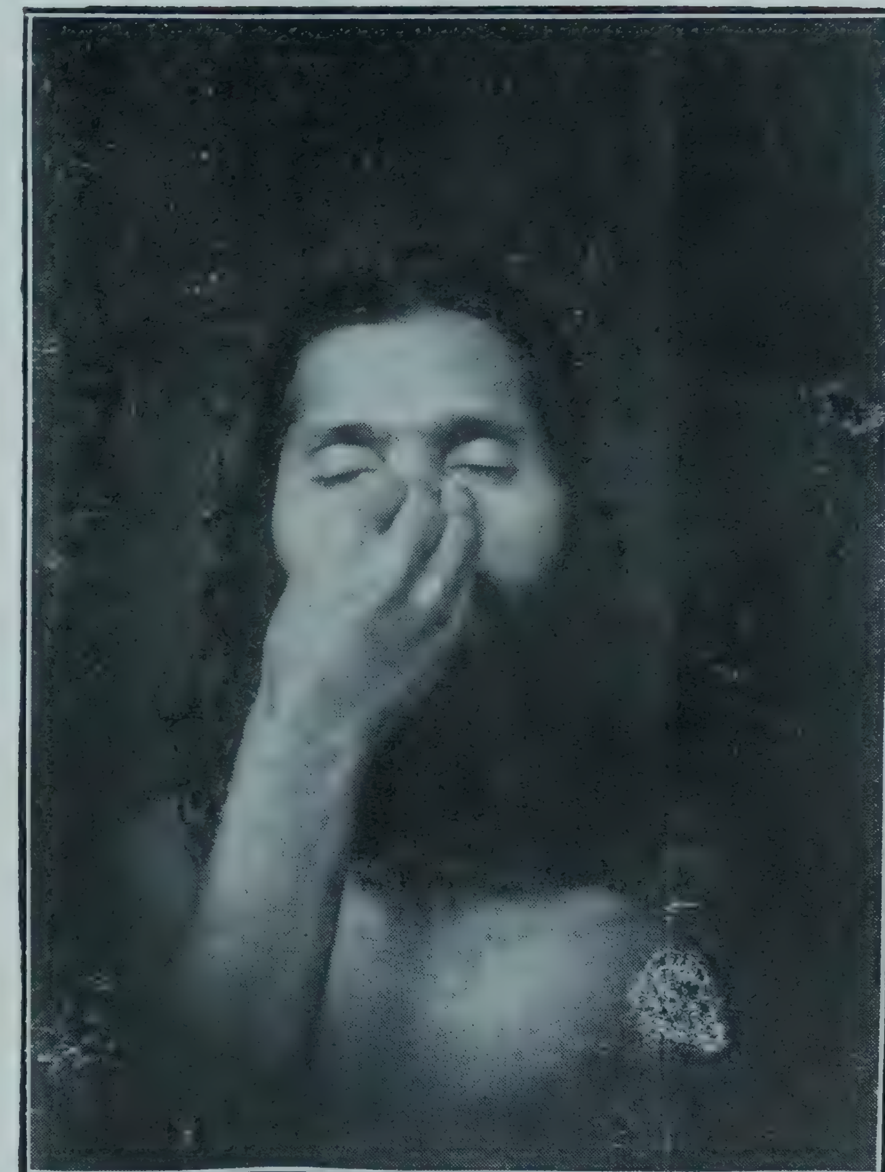
The Left Nostril Closed

Fig. LXIX



Both the Nostrils Closed.

Fig. LXX



Both the Nostrils Open.

two cases. (See Fig. LXIX). But if both the nostrils are to be kept open, there are two positions for the right hand. The fingers and the thumb may rest on the bridge of the nose or the right hand may be taken down to rest on the knee as shown in Fig. LXI or LXIII. The first position is preferable, when alternating with the open nostrils, one of the nostrils is to be kept closed, as in the case of Ujjāyī. But the second position should be preferred, if there is no alternate closure of the nostrils. Now we come to Pūraka.

Every Pūraka, including the first, is to start after complete exhalation. In Ujjāyī, breath is to be drawn in through both the nostrils. In drawing in the breath the work is to be done with the chest. The student is to expand it and air will automatically rush in. Throughout the inhalation, the glottis is to be partially closed. This partial closure of the glottis will produce a continuous sound like the sound that is produced in sobbing. The difference is that in sobbing the sound is abrupt and broken. Here it is continuous. At the time of inhalation the facial muscles or the muscles of the nose should not be contracted. The contraction of facial muscles is of absolutely no use in inhalation. Some people are in the habit of having ugly contortions of the whole face, when they try to inhale. (Fig. LXVI). This is to be completely avoided. Special care is to be taken of the abdominal muscles. They should be kept under proper control with a very slight contraction which is to be maintained throughout the inhalation. Fig. LXXI[1] illustrates this control. It can be better observed in Fig. LXXII which shows a side view of the same position. Fig LXXIII represents the controlled abdomen at the end of the inhalation. Here again Fig LXXIV which gives a

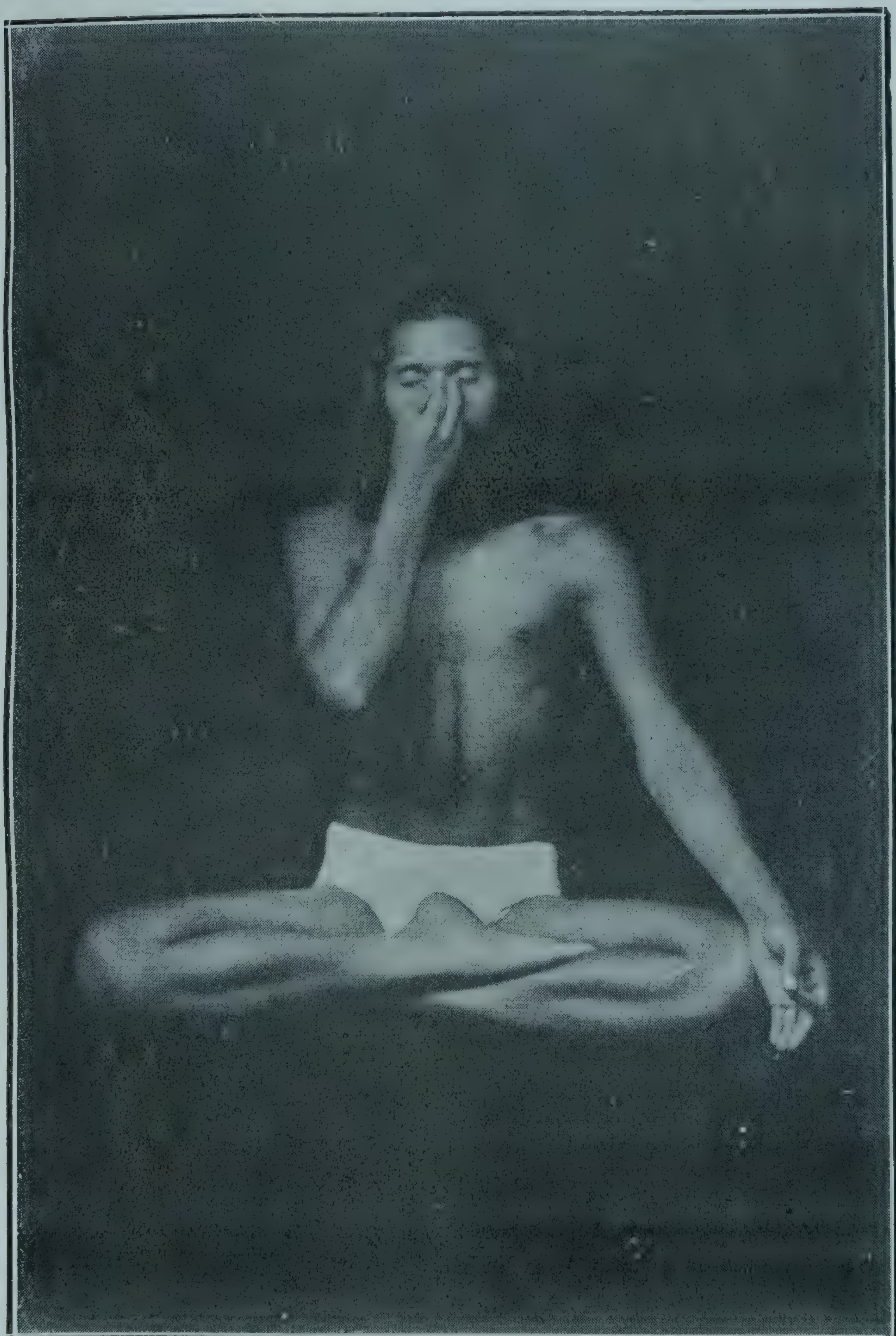
1 In this and the following pictures given in this article, the position of the right hand on the nose does not refer to Ujjāyī. The photographs are intended to be of general use in illustrating positions in Prāṇāyāma.

side view of this very position, gives a better idea. The Western physical culturists advise their followers to draw out the abdomen at the time of inhalation. In our opinion this is due to some wrong conceptions about the physiology of deep breathing. We do not say Prāṇāyāma, but purposely use the word *deep breathing*. In the next issue we shall discuss the advantages of a controlled abdomen and also of a protracted abdomen, strictly on a scientific basis; and hope to prove that the Yogic method of keeping the abdomen controlled, is more scientific even from the point of view of physical culture. To illustrate full inhalation with protracted abdomen, we have given Fig. LXXV. Fig LXXVI represents the side view of the same. A comparison between Figs. LXXIV and LXXVI will very vividly indicate the contrast between a controlled and a protracted abdomen. The whole course of inhalation must be smooth and uniform. The accompanying sound due to the friction offered by the partially closed glottis, should also be of a low but sweet and uniform pitch. All friction in the nose, especially in the olfactory region, should be cautiously avoided. It is this friction that is very often responsible for the brain disorders at times arising from the wrong methods of Prāṇāyāma. When the limit of inhalation is reached, there should be no convulsive effort at snatching an additional breath. No amount of muscle twisting will draw in even one more c.c. of air. As soon as the inhalation is completed, Kumbhaka should start.

KUMBHAKA :—

Out of the various types of Kumbhakas referred to in our article on Prāṇāyāma, Ujjāyī requires the Abhyantara Kumbhaka, that is, Kumbhaka practised after deep inhalation. The first thing that demands our attention in this Kumbhaka is the complete closure of the glottis. This thoroughly shuts off the passage to and

Fig. LXXI



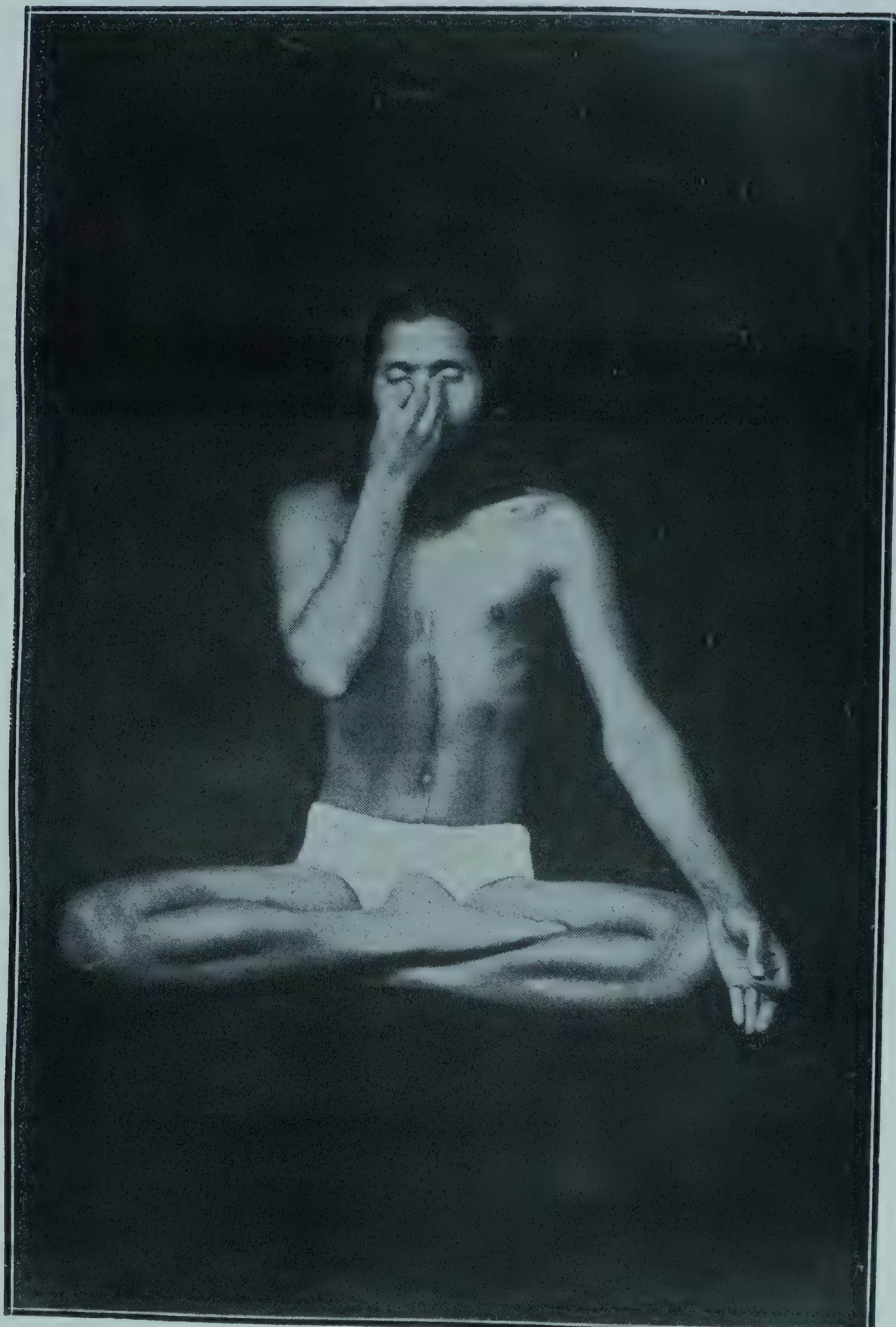
Starting Inhalation with Controlled Abdominal Muscles.
(Front View)

Fig. LXXII



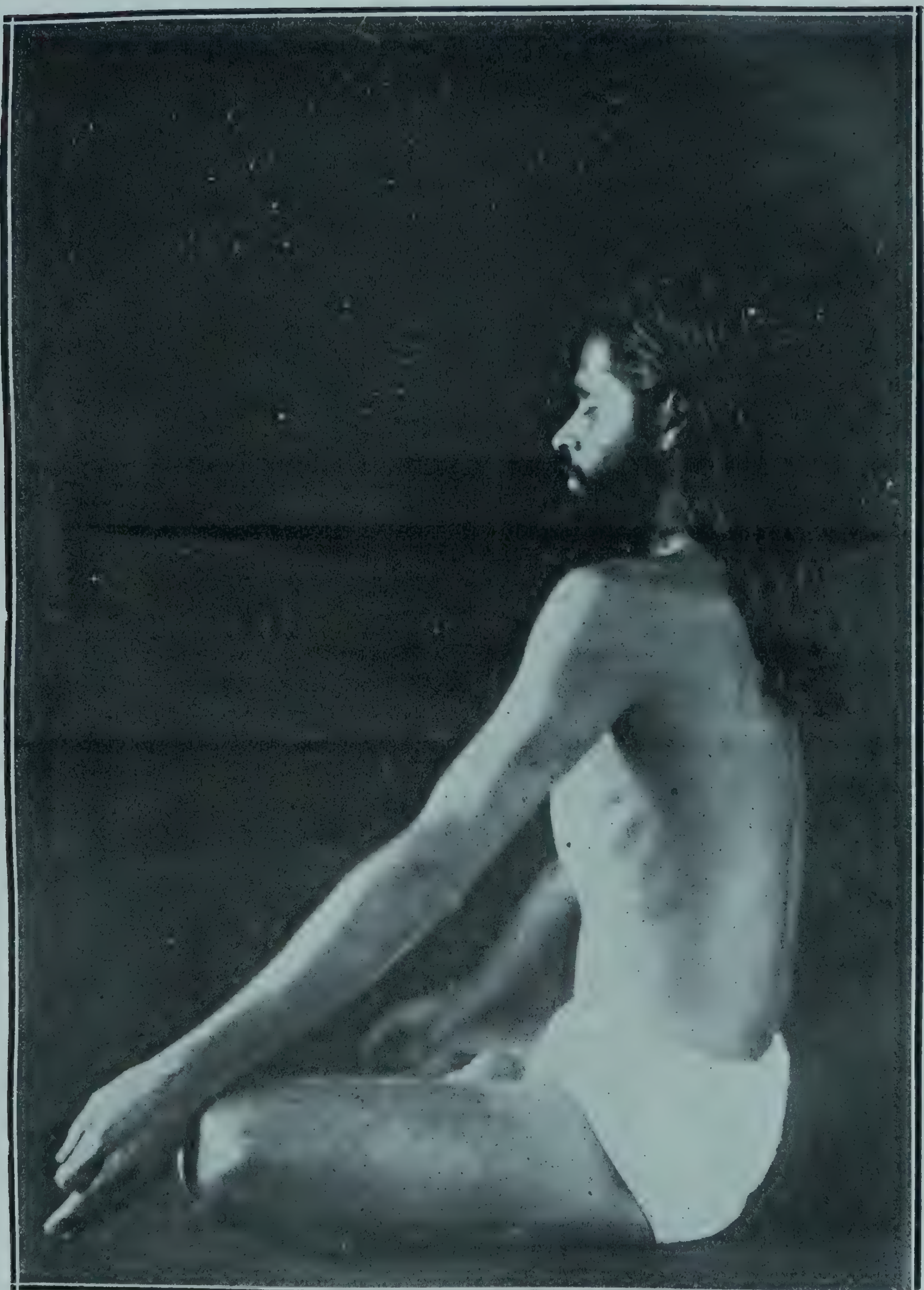
Starting Inhalation with Controlled Abdominal Muscles.
(Side View)

Fig. LXXIII



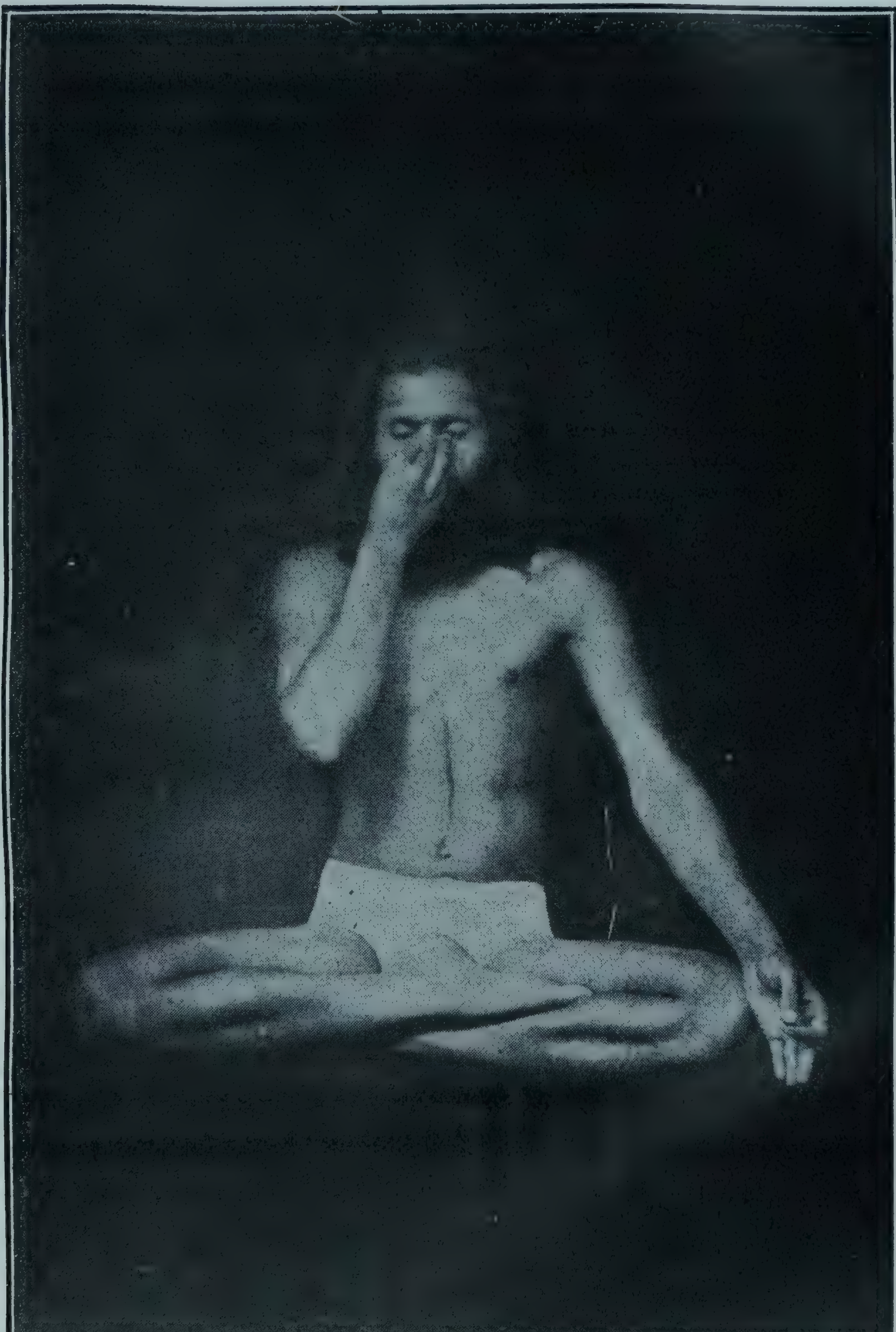
Full Inhalation with Controlled Abdominal Muscles.
(Front View)

Fig. LXXIV



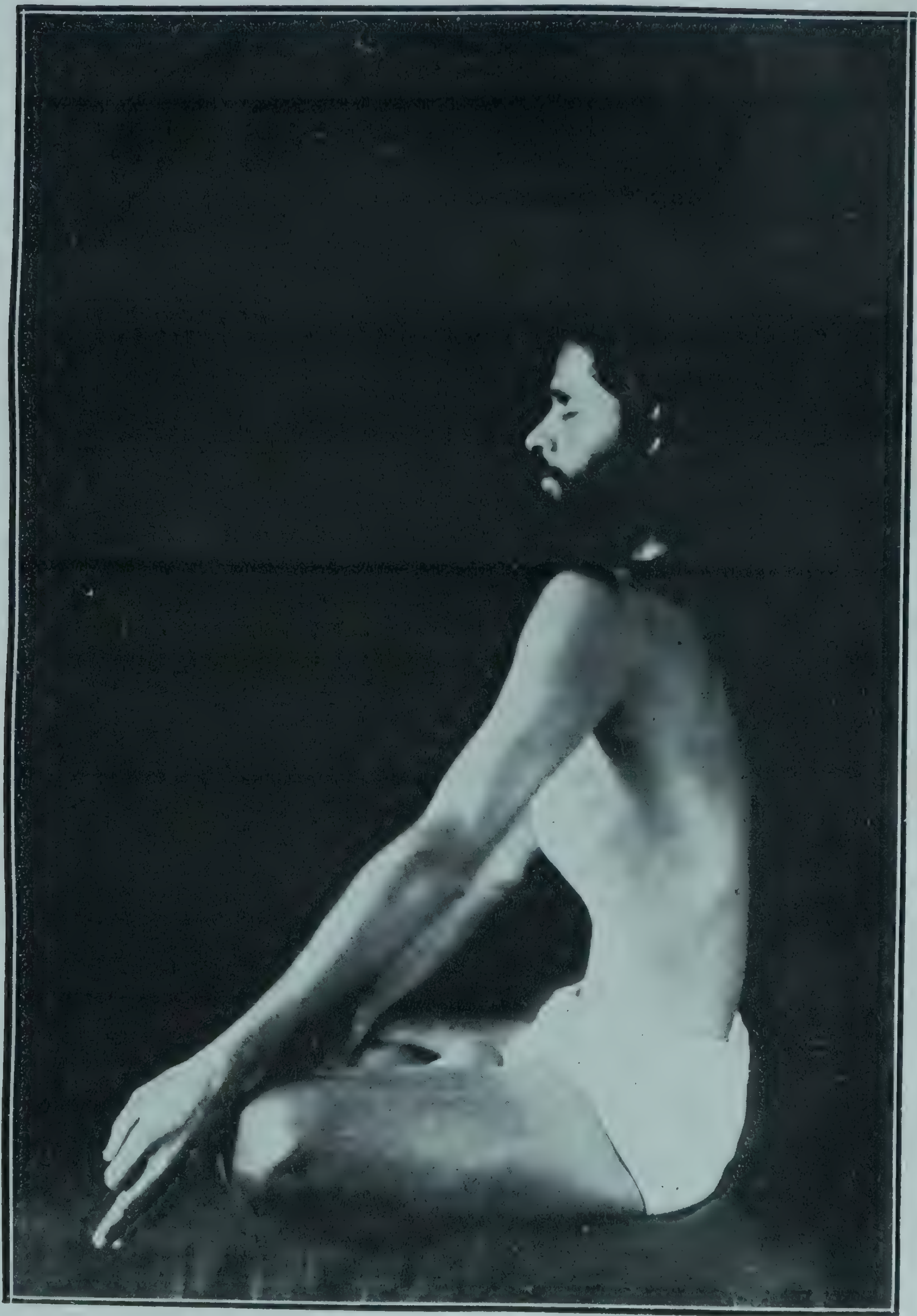
Full Inhalation with Controlled Abdominal Muscles.
(Side View)

Fig. LXXV



Ftll Inhalation with Protracted Abdomen.
(Front View)

Fig. LXXVIII



Full Exhalation.
(Side View)

from the lungs. The second thing is the practice of Jālandhara-Bandha (vide volume ii, p. 226), and the third is the shutting of the nostrils. The tightly closed glottis establishes the first and the most effective line of defence against the inspired air that constantly tries to break through the air passage during the interval of Kumbhaka. Jālandhara-Bandha by thoroughly contracting the pharynx offers the second line of defence. The third line of defence requires no explanation. It is to be noted that when the first line fails, the second and third lines are not able to successfully withstand the onset of the air. Nor is it desirable to attempt any such thing, because such an effort is likely to lead to untoward consequences.[1] The second and third lines are there, only to support the first line in its work.

It is to be borne in mind that the glottis will be able to do its work only so long as the walls of the chest stand firm with the elevated ribs. So the contraction of the muscles of inspiration secured at the end of the inhalation, is to be maintained throughout Kumbhaka.

The slight contraction of the abdomen is to be carefully maintained. As will be shown in the first number of the fourth volume, the real advantage of Kumbhaka lies in this abdominal contraction. Here we must make a brief reference to the popular belief according to which the real advantage of Kumbhaka consists in the larger quantities of oxygen being absorbed into the system, on account of the retention of air in the lungs. We are conducting laboratory experiments to test the truth of this belief. Although our experimental evidence is yet very meagre, it is sufficient to indicate that there is not much truth in this belief. We shall be able to publish this and any additional evidence that we may collect hereafter, on some future occasion.

1 These will be scientifically discussed in the next issue.

The time limit of Kumbhaka should be made to depend upon two things. (1) While Kumbhaka lasts no serious sense of suffocation should be experienced. (2) At the end of Kumbhaka, the student must have as much control over his lungs as would make a smooth and proportionate Rechaka possible. If these conditions are attended to, there is no danger of damaging either the lungs or the heart, in the case of a man of average health.[1]

The time proportion between Pūraka and Kumbhaka is either 1 : 4 or 1 : 2 as stated in the article on Prāṇāyāma. A beginner will do well to follow the latter. But whatever the proportion, the measure of Kumbhaka should first be determined as stated in the foregoing paragraph and then a proportionate time be fixed for Pūraka.

When Kumbhaka is to end first relieve the pressure from the left nostril, then unlock Jālandhara-Bandha and afterwards partially open the glottis. The thorax is to be relaxed only when the air passage is left open. With the relaxation of the chest, Rechaka starts.

RECHAKA :—

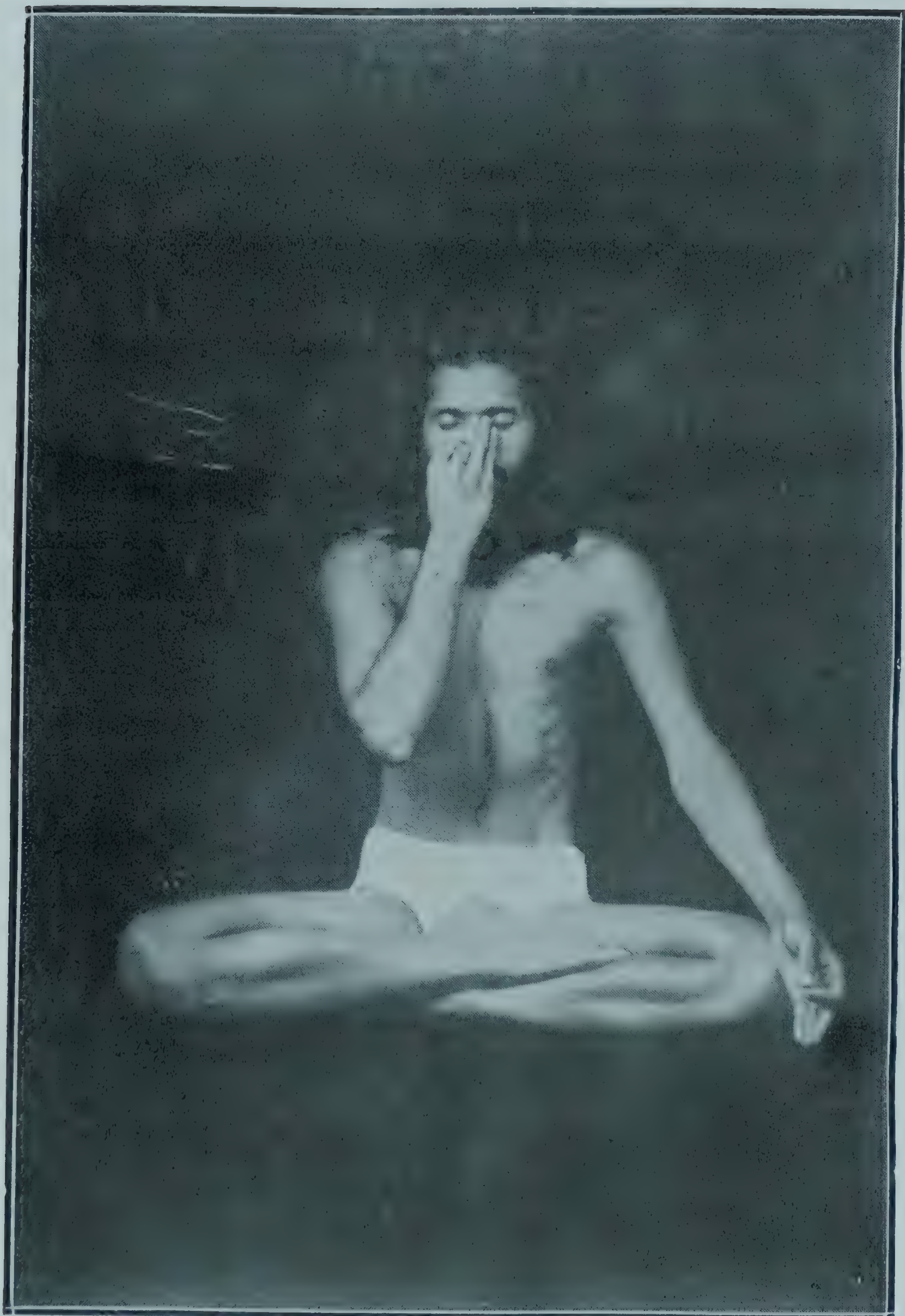
Rechaka is to be done through the left nostril. At no stage during Rechaka should the student lose his control over his lungs. The relaxation of the chest should be slow and uniformly progressive to the end. The glottis should all along remain partially closed. The frictional sound due to this partial closure, should be of a low but uniform pitch.

From the very beginning of Rechaka, the abdominal muscles undergo greater and greater contraction. Even

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1 People suffering from pulmonary or cardiac disorders will do well not to practise Prâṇâyâma, and especially Kumbhaka, save under expert supervision.

Fig. LXXVII



Full Exhalation.
(Front View)

Fig. LXXVIII



Full Exhalation.

(Side View)

when the chest shrinks to its lowest size, the abdomen should continue to contract, till at last the last c.c. of the supplemental air is expelled. Figs. LXXVII and LXXVIII represent a thoroughly contracted abdomen. This does not mean that in Rechaka any amount of strain can be put upon the system. It only means that the exhalation should be as thorough as can be secured without involving any undue strain. Our readers may, however, note here that in Rechaka there is less possibility of unduly straining oneself than in Pūraka or Kumbhaka. There is another point of difference that deserves attention. In the case of an average man of health, Pūraka and Kumbhaka, if developed beyond the right proportion, are likely to damage the lungs more than the heart; whereas an unduly deep Rechaka is likely to affect the heart more than the lungs. Why this is so, we shall explain scientifically in some future issue.

Rechaka should always take a longer time than Pūraka. The orthodox proportion between Pūraka and Rechaka is 1 : 2. An attempt should be made to reach this standard. Here again one has to bear in mind that Rechaka should never be so prolonged as to make the following inhalation any way hurried. In fact in fixing up the proportions of the three component parts of a Prāṇāyāma, that is, of Pūraka, Kumbhaka and Rechaka, one has to see that one can perform with comfort, not only one Prāṇāyāma, but all the successive Prāṇāyāmas also. If at a sitting one wants to go through, say, fourteen rounds of Ujjāyī, one should never feel the need of snatching a normal breath in between any two successive rounds, till all the rounds are finished. No undue sense of suffocation should be experienced at any stage in the practice of Prāṇāyāma, whatever the number of rounds that one wants to have at a time. So necessary care is to be taken not only in fixing up the component

parts of a single round, but also in fixing up the total number of rounds one wants to go through at one sitting.

THE TOTAL DURATION OF A SINGLE ROUND :—

This will necessarily depend upon the capacity of every man. Without giving our reasons just now, we may state the following rules.

i A spiritual culturist should try to prolong the duration of each round.

ii A physical culturist who looks to the oxygen value alone of the performance, should try to shorten the duration of each round.

iii A physical culturist who looks to the other values in addition to the oxygen value, should try to have four rounds a minute.

CONCENTRATION :—

A spiritual culturist should concentrate his attention upon that point in the nasal part of his pharynx where the first touch of the inhaled air is felt. This point is situated just behind the anterior openings of the nasal passages, in the dome of the nasal pharynx, directly above the top of the arch formed by the junction of the hard and soft palates. In exhalation the last touch of the exhaled air will be felt at this very point. Concentration on this point is to be maintained throughout Prāṇāyāma whether one is doing Pūraka, Kumbhaka or Rechaka.

A physical culturist should concentrate his attention upon the air he breathes. During inhalation and exhalation it should be marked at the glottis as it meets with friction there. During Kumbhaka the concentration should be on the air held in the chest.

In this connection there are many other points of importance both for the physical and spiritual culturists. But there is time yet for them to be discussed in these pages.

GENERAL HINTS :—

As stated in our article on Prāṇāyāma a beginner whether he is a physical culturist or a spritual culturist, will do well to practise Ujjāyī without Kumbhaka. For the former Kumbhaka is not necessary, unless he wants to perform such feats of strength as are exhibited by Prof. Rāmamūrti and his imitators. Even for a spiritual culturist the need of Kumbhaka arises after a good deal of progress. At any rate a novice should avoid Kumbhaka for some days at least and when it is to be taken up, utmost care should be taken against undue strain.

There is another point which we shall recommend to our readers. Even in Ujjāyī, Rechaka may be practised with both the nostrils. We know that this change is not in keeping with the orthodox technique, but it will be found very convenient by beginners. Again we do not think that this change will much affect the expected results.

In case this recommendation is taken up and also that of dropping Kumbhaka, there remains no need of using the right hand for closing the nostrils.

What should be the total number of rounds to be practised daily and how these rounds should be distributed ?

For a spiritual culturist the maximum number of rounds is 320. This is to be distributed over two to four sittings according to one's convenience. A physical culturist should satisfy himself with a total of 240 to be finished in two instalments. For him the morning and evening hours are the best.

By both the types of Yogic culturists, a beginning can be made with seven rounds at each instalment, adding three rounds to each instalment per week. For several years we have found this to be a very safe programme, the same having been tried in thousands of cases.

The whole treatment accorded to the subject here, is from the point of view of an average man of health. People not suffering from any serious trouble either of the heart or of the lungs, can also follow these instructions with suitable changes. But any one suffering from a pulmonary or cardiac disorder, is strictly warned against taking to these practices on his own responsibility. He must consult an expert.

Miscellaneous

Following diseases, especially in their chronic condition can be effectively treated by the Yogic methods :

1 *Constipation.*
2 *Dyspepsia.*
3 *Head-ache.*
4 *Piles.*
5 *Heart-disease (functional).*
6 *Neuralgia.*
7 *Diabetes.*
8 *Hysteria.*
9 *Consumption.*
10 *Obesity.*
11 *Sterility (certain types).*
12 *Impotence.*
13 *Appendicitis, &c.*

Therapeutical advice is given gratis at the Āśrama to patients coming for consultation.

Arrangements have been made under the supervision of the Āśrama for patients to stay on payment of actual expenses, Rs. 45/– per mensem.

THE KAIVALYADHĀMA SPIRITUAL SERVICE

GENERAL

The Kaivalyadhāma was established at the end of 1924. Within four years its Director, Śrīmat Kuvalayānanda, found that the ideals for which the Āśrama stood and the practical work it was doing were appreciated not only throughout the length and breadth of India, but also outside the limits of the Indian Nation. Everything clearly indicated that there was a distinct demand for similar centres all over the country. Information from reliable sources reached the Director stating the possibility of developing centres of the Āśrama in France, Germany and America. Thus it came to be fully realized that the Kaivalyadhāma must have a band of well trained spiritual workers who could preach the ideals of the Āśrama and lead the movement for realizing these ideals at different places all over the civilized world. Again it was desirable that these workers did not put in isolated work of an individual character and that their efforts were not of a spasmodic nature as is generally the case in the field of spiritual activities in India. It was, therefore, thought essential to establish a thoroughly organized spiritual service instituted on a democratic basis with well defined rules of conduct. Towards this end, taking advantage of an anniversary, the eighth, of Paramahaṅsa Śrīman Mādhavadāsajī Mahārāja, the Master of Śrīmat Kuvalayānanda, the latter founded The Kaivalyadhāma Spiritual Service on the 6th of January, 1929, with himself as the First Member. Arrangements were also made simultaneously to start an academy called S'rīman Mādhava Yoga Mandira for the training of probationers wishing to join the Spiritual Service. The following rules and regulations were adopted by S'rīmat Kuvalayānanda at the foundation of the Kaivalyadhāma Spiritual Service, the same being capable of revision from time to time according to the needs of the Service thus founded.

RULES AND REGULATIONS

1 The following will be the duties of the Kaivalyadhāma Spiritual Service:—

i To be responsible for the entire management of the Kaivalyadhāma in all its departments, and to devote the best of their energy in conducting the scientific research work in the field of psycho-physiology, spiritual culture, etc. The members of this Service will form the Regulating Council of the Kaivalyadhāma in accordance with the provisions made in this connection in sections 19—22, 26 and 27; and will manage the affairs of that Āśrama in accordance with the Rules and Regulations passed from time to time by this Council.

ii The First Member of the Kaivalyadhāma Spiritual Service will be the *ex officio* Director of the Āśrama. Unless otherwise reserved, all duties involved in the management of the Kaivalyadhāma will belong to him.

iii To strive selflessly for the spiritual uplift of mankind irrespective of one's caste, creed and country.

iv To reach therapeutical relief to ailing humanity especially through Yogic Therapy.

v To study the currents, under currents and cross currents of different civilizations with a view to divert them through proper channels.

vi To investigate theoretically the noblest parts of all human institutions and to take practical steps for realizing the highest ideals of man in his different activities. Practical politics is the only activity to be completely eliminated from the programme of the Kaivalyadhāma Spiritual Service.

vii To develop an ideal system of physical culture based as far as possible on the practices of Yoga; and to take active steps for the spread of the system thus evolved.

2 The Kaivalyadhāma Spiritual Service is divided into three grades—

i International.

ii National.

iii Provincial.

3 S'rīmat Kuvalayānanda has made himself the First Member of the Spiritual Service. He will continue to do the duties of the First Member so long as he remains an active member of the Kaivalyadhāma Spiritual Service. He binds himself to obey the constitution of the Āśrama on the following conditions.

i The first five years which he has put in, in the service of the Āśrama are recognized as a part of the total period of membership.

ii As soon as the Āśrama is well organized he is relieved from active work.

iii He is placed in the Provincial Grade to start with.

4 Members will be admitted to the Spiritual Service only on the approval of the First Member who will make his selection from any of the following groups.

i Those that successfully pass the S'rīman Mādhava Yoga Mandira, after being there under training for four years.

ii Those that are so developed in Yoga as to sit in Nirvikalpa Samādhi.

iii Those that are double graduates of a reputed university with a bright career at some well-known college, and have already done or have an immediate capacity to do some original research work useful to the Āśrama.

iv Those that possess an equally high academic qualification though they may not belong to any university.

5 The First Member in making his selection, referred to in the previous section, will always see that the intending member

has put in a candidature of at least two years at the Āśrama before he is abmitted to the membership of the Provincial Grade.

6 No one that does not take a vow of chaste unmarried life or having been married does not bind himself to be a lifelong celibate will be admitted to the Kaivalyadhāma Spiritual Service.

7 No one that cannot fluently speak or write English and a provincial language can get admission to the Kaivalyadhāma Spiritual Service.

8 Every member of the Provincial Grade stands the danger of being disqualified at the end of two years after his admission to that Grade, provided always a majority of the then existing members of the Regulating Council deem it desirable to disqualify him in the interest of the Kaivalyadhāma.

9 Any member of the Spiritual Service may be disqualified in the interest of the Kaivalyadhāma at any time during his career at the Āśrama, provided his disqualification is recommended by a majority of three-fourths of the then existing members of the Regulating Council. The member to be disqualified will have a right to defend himself; but the Regulating Council do not bind themselves to give reasons for recommending the disqualification.

10 A member of the Provincial Grade will be raised to the National Grade, provided always a majority of the then existing members of the Regulating Council are of opinion that the member concerned has for his sphere of influence an area larger than a province.

11 Similarly a member of the National Grade will be raised to the International Grade, provided always a majority of the then existing members of the Regulating Council are of opinion that the member concerned has for his sphere of influence an area wider than a nation.

12 Every member of the Spiritual Service will work at least for twenty years including two years of furlough.

13 During his term of membership every member of the Kaivalyadhāma Spiritual Service will have no personal property

and will not seek any channel of earning money to be used either by himself or by his relations and friends.

14 Should a member of the Kaivalyadhāma Spiritual Service happen to possess personal property before he comes to be admitted to membership, he would be allowed to continue its possession, provided always that such a member neither takes advantage of his property during the term of his membership nor is required to attend to its management in a way that would interfere with his duties in the Service.

15 If a member happens to be an author, he will have no copyright of his publications brought forth during the period of his membership. Such a copyright would belong, for ever, to the Āśrama automatically. This does not apply to any books written after the member's retirement.

16 Should a member during the term of his membership invent an instrument or any other article of marketable value, the instrument or article invented shall belong to the Āśrama, for ever, automatically, and shall be patented and registered in the name of the Kaivalyadhāma. The inventing member will have no right either to manufacture or sell the instrument or article in his invidual capacity or to make any money therefrom either during the term of his membership or thereafter. This does not apply to the instruments or other articles invented by a member after his retirement.

17 During the term of his office every member of the Kaivalyadhāma Spiritual Service will be maintained by the Āśrama according to the bye-laws enacted by the Regulating Council from time to time in this connection.

18 After satisfactory service for the stipulated period every member will be entitled to a lifelong pension of Rs. 25/– per month.

19 All members of the International and National Grades plus the First Member, even if he does not belong to these grades, will have each a seat on the Regulating Council.

20 Members of the Provincial Grade other than the First Member will elect from among themselves their representatives

on the Regulating Council, in the proportion of one to three, according to the bye-laws that may be framed in this connection from time to time by the Regulating Council.

21 Even when the numerical strength of the Provincial Grade excluding the First Member falls short of three, these members will have a right to have one representative on the Regulating Council.

22 Elections for a membership of the Regulating Council will take place every fifth year, dating from the year of first election which in its turn will be fixed by the First Member. Should a necessity occur for a fresh election between any two successive elections, the First Member has the power to arrange for such an election and to admit a new representative on the Regulating Council.

23 As soon as possible the First Member will institute a fourth type of spiritual service to be called Village Service.

24 The following will be the duties of the members ot the Village Service—

i To devote the best of their energies to the spiritual uplift of Indian villages.

ii To work selflessly for the economic reconstruction of rural areas in India.

iii To improve the sanitary conditions of Indian villages.

iv To undertake any other type of work that may lead to the general improvement of Indian villages.

25 The First Member will admit to the membership of Village Service people, on conditions similar to those on which he would admit members to the Provincial Grade, with the following changes—

i Intending members of the Village Service will have passed the Short Course instead of the Academy.

ii They will have reached some higher stage in spiritual evolution but not necessarily the stage of Nirvikalpa Samādhi.

iii They must have capacity for practical village work instead of capacity for original research.

26 Members of the Village Service will elect for every six of them one representative on the Regulating Council, every fifth year, dating from the year of the first election which in its turn will be fixed by the First Member.

27 Retired members either of the Kaivalyadhāma Spiritual Service or of Village Service will have their representation on the Regulating Council. Rules and Regulations in this connection will be framed by the Regulating Council on the eve of the retirement of the first member belonging to either of these services.

TRAINING FACILITIES AT THE KAIVALYADHĀMA

All sorts of facilities are created at the Kaivalyadhāma for the study of Yoga in all its aspects. To every earnest seeker of Adhyātma, spiritual instruction is given gratis for any length of time. Even a few days' stay at the Āśrama may, indeed, look sufficient to make a beginning. As the Director does not believe, however, in a man's ability to make a successful beginning in a few days, real studentships are available from six months to a lifetime.

Students willing to undertake some work at the Āśrama are boarded and lodged free. So also those that wish to serve humanity throughout their life under the auspices of the Āśrama are given every help to develop themselves not only spiritually but also intellectually. These people, when developed, are given full share in the management of the Āśrama.

To the most capable of the lot, Yoga is taught not only from the spiritual point of view but also from the point of view of physical culture and therapeutics. Arrangements have been made for teaching not only the Yogic philosophy but also allied philosophies of the East and the West. Provision has been made for the study of Anatomy and Physiology as well.

An efficient staff is working for this purpose. An excellent reading room, a tolerably equipped library, nicely furnished laboratories, a well attended health resort, comfortable residential quarters, satisfactory boarding arrangements, all go to make a student's life almost as enviable as it is efficient. Situated at the foot of a hill on the heights of the Sahya mountains, the Āśrama is cut off from the bustle and din of the modern society, and a serene atmosphere characteristic of spiritual evolution perpetually settles over the whole of the Kaivalyadhāma.

Detailed Rules and Regulations for Students are given on the following few pages.

RULES AND REGULATIONS

for

STUDENTS

GENERAL

1 No one will be admitted as a student to the Āśrama that does not come to it for spiritual evolution.

2 A studentship is available at the Āśrama only to those who look upon Yoga as a means to self-realization.

3 No male below the age of puberty and no female of whatever description will be admitted to the Āśrama as a student.†

4 Moral excellence is an absolutely necessary qualification for being admitted to a studentship in the Āśrama.

5 No one that is suffering from a serious defect in the body or brain will be admitted to the Āśrama as a student.

6 Students who are still under the guardianship of an elderly person shall not be admitted to the Āśrama without the consent of their guardians.

7 Admission as students will be granted only to those who are either known to some one of the present inmates of the Āśrama, or to those who can produce satisfactory references from some respectable person of their place.

8 A probationary period of two to six months according to the discretion of the Director, is compulsary for every one before he is confirmed in his studentship.

9 Students when admitted will have to obey the discipline of the Āśrama in every detail.

10 Even a day's absence without leave from the Āśrama will be considered a serious breach of discipline.

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† Howsoever anxious we may be to provide for the Yogic instruction of candidates of both the sexes, our present circumstances put the thing practically out of the question.

11 This or any other serious breach of discipline will entail an immediate expulsion from the Āśrama.

12 There are four types of studentship instituted in the Āśrama: (1) Short Period Paying Studentship ; (2) Short Period Working Studentship ; (3) Permanent Studentship; (4) Studentship leading to Probation at the Academy.

13 No student falling under any of these categories will be charged any fees for Yogic instruction which will ever be given absolutely gratis.

14 Persons losing their studentship not for any serious breach of discipline, are not precluded from applying for a studentship again.

15 First two types of studentship are available even to married persons provided they undertake to follow the Yogic code of sex morality. The last two types are open only to celibates or to married men undertaking a lifelong vow of celibacy.

SHORT PERIOD PAYING STUDENTSHIP

16 Any one that satisfies the general conditions and undertakes to pay Rs. 35/- in advance every month for his actual expenses, will be admitted to the Āśrama for a Short Period Paying Studentship. The Director, however, reserves to himself the right of refusing admission to candidates and is not bound to explain reasons for such a refusal.

17 Short Period Paying Studentship is available for a minimum period of six months and a maximum period of six years only.

18 Should a candidate wish to stay in the Āśrama for a period less than six months or more than six years, he should do so either as a Visitor or as a Permanent Student respectively.

19 Not more than two months' leave will be granted to a student in a year, every time absence being allowed strictly on grounds of emergency.

SHORT PERIOD WORKING STUDENTSHIP

20 Candidates that satisfy the general conditions but are not in a position to pay or being in a position, do not wish to do so, may be given Short Period Working Studentship in the Ās'rama, provided they undertake to do such work in the Ās'rama as may be assigned to them from time to time by the Director or in the absence of the Director by his representative.

21 The character and amount of work will be such as will not interfere with Yogic practices of such students. But in times of emergency they are expected voluntarily to look to the interest of the Ās'rama even at some sacrifice of their Yogic studies, additional work put in under such circumstances being sure to help them in their spiritual evolution.

22 Candidates to be admitted to this class must not only be very sound in body and mind, but must possess intense hankering for spiritual evolution through Yogic life.

23 No candidate will get a Working Studentship at the Ās'rama if he has completed his thirtieth year. The younger the candidate the more preferable he will be.

24 No candidate that has directly to shoulder any family responsibilities will be admitted to this class of studentship.

25 The Ās'rama will be responsible not only for the boarding and lodging of the Working Students during their stay at the Ās'rama, but also for the satisfaction of their ordinary wants as students of Yoga. Should a student, however, incur expenses even in the performance of his legitimate duties in other capacities, he he should make his own arrangements to defray them.

26 Not more than one month's leave will be granted to a student in a year, every time absence being allowed strictly on grounds of emergency.

27 Working Studentship is available only for a minimum period of four years.

28 Students of this class must offer themselves as subjects for any Yogic experimentation that may be conducted on behalf of the Ās'rama.

29 Those that begin their stay in the Ās'rama as Working Students are not precluded from getting later on either a Permanent Studentship or a Studentship Leading to Probation at the Academy.

PERMANENT STUDENTSHIP

30 Permanent Studentships are available only to those that want to make Yoga their life-work, completely indentifying themselves with the Ās'rama and its activities in the Yogic field.

31 Only those celibates that are from sixteen to twenty-five years of age and that have full confidence in their capacity to continue their chaste celibacy to the end of their life, will be admitted to this class.

32 Under exceptional circumstances even a married man may be admitted to a Permanent Studentship, provided always that the intending student takes a lifelong vow of celibacy and that his responsibilities are not such as would disturb him in his pursuit of Yoga.

33 Any family tie that would disturb an exclusive Yogic life will constitute a disqualification for a candidate of this class.

34 Permanent Studentship will be available only to those that have a special aptitude for Yogic culture.

35 The Ās'rama undertakes to satisfy all legitimate needs of a Permanent Student while he is attached to the Ās'rama.

36 Should a Permanent Student be a married man, the Regulating Council shall make provision for the maintenance of his immediate dependants, not more than three in number, when such a student is admitted to a membership of the Ās'rama.

37 Such of the Permanent Students as are not taken up in the Kaivalyadhāma Spiritual Service, or being offered to be taken up in the Village Service, are not inclined to enter it, shall remain in the Āsʼrama as Student Members, this membership being available to them at the recommendation of the Director after six years of satisfactory Permanent Studentship.

38 Student Members will be bound by the same rules and regulations as the members of the Village Service.

STUDENTSHIP LEADING TO PROBATION AT THE ACADEMY

39 Such of the Permanent Students as are capable of being trained for the Kaivalyadhāma Spiritual Service, will be awarded this type of studentship. These students will have to put in one year of candidature before they are admitted to the Academy.

40 During the year of candidature, students referred to in the preceding section will obey the same rules and regulations as the Permanent Students.

S'RĪMAN MĀDHAVA YOGA MANDIRA

or

THE MĀDHAVADĀSA ACADEMY OF SPIRITUAL CULTURE

GENERAL

1 The Academy is founded with a view to train probationers for the Kaivalyadhāma Spiritual Service.

2 The Director of the Kaivalydhāma is to be the *ex-officio* Kulapati of the Academy.

3 The course at the Academy extends over four years and every probationer has to maintain a satisfactory progress throughout this period.

4 The Academic year begins in January and ends in December. Every year is divided into two terms. The first term begins on the 16th of January and ends on the 15th of June. The second term begins on the 16th of September and ends on the 15th of December.

5 Probationers are admitted to the Academy every alternate year.

RULES OF ADMISSION

6 Candidates are admitted to probationership at the Academy by the Kulapati on the following conditions.

> i Every candidate must have intense spiritual hankering to be satisfied through spiritual evolution attainable in Yoga.
>
> ii Every candidate must take a vow of leading chaste unmarried life or having been married must take a vow of lifelong celibacy.

iii Every candidate must have passed a test in candidature instituted at the Ās'rama by the Regulating Council or by the Director till the Regulating Council is formed.

iv Every candidate must bind himself to be at the Academy for four years, and to be admitted to the Spiritual Service in accordance with its rules and regulations, if the First Member desires him to be taken up.

v During the four years of probation every candidate must obey the bye-laws enacted in this connection from time to time by the Regulating Council or by the Director till the Regulating Council is formed.

vi Every candidate must have educational qualification equal to that of a smart Matriculate. He must have grounding in Physics and Chemistry and a tolerably good knowledge of Sańskṛita and Hindi.

vii No candidate will be taken up for probation if he is not physically fit.

viii Every candidate to be admitted to the Academy must be below twenty-five, although seniority in age will be liberally condoned, provided the other conditions are thoroughly satisfied.

SUBJECTS

7 The following subjects are offered for study—

i Practical study of the different Yogas suited to the candidates for self-realization.

ii Theoretical study of the science and art of Yoga.

iii Āryan Philosophy to be studied in original Sańskṛita texts.

iv Western Philosophy in general and Psychology, Metaphysics and Mysticism in particular.

v Elementary Anatomy.

vi Elements of Physiology.

vii Elements of Hygiene.

viii Practical knowledge of Clinical Methods.

ix Yogic Therapeutics, theoretical and practical.

x Theoretical study of Physical Culture in general.

xi Theoretical and practical study of Yogic Physical Culture.

xii Studies in General Economics with special reference to the Economics of India.

xiii An outline of the Constitutional History of the leading nations of the world.

THE STAFF

8 As shown on page 306, the Academy has a small but efficient staff of tutors. One vacancy remains yet to be filled. The seat will shortly be occupied by some competent man.

THE EQUIPMENT

9 Although the Academy has not got its own equipment in the form of laboratories, library, reading room, health home etc., all this equipment is available to it through the Ās'rama, as shown in the following sections.

10 For the study of anatomy an anatomical museum is maintained under a Curator where anatomical parts are preserved for study. Anatomical models are also made available. Excellent anatomical charts are provided for study. This is just sufficient for acquiring the anatomical knowledge necessary at the Academy. For probationers capable of undertaking anatomical research work in Yoga, arrangements are made for dissection after their passing the Academy.

11 For the study of Physiology a moderately equipped laboratory is available.

12 For practical work in clinical methods the Rana Nataverasingh Clinical Laboratory of the Ās'rama is available. Probationers will be working under the House Surgeon at this Laboratory for their practical training. As many as four hundred patients are examined every year in this Laboratory. Hence working under the House Surgeon here will give sufficient training in practical clinical methods.

13 For practical training in Yogic Therapy, the Yogic Health Resort of the Kaivalyadhāma is available. Every year about two hundred patients receive indoor treatment at this Health Resort. Probationers will be made to do clinical work under the Director in treating these patients Yogically. Thus the Yogic Health Resort will afford sufficient facilities for practical training in Yogic Therapy.

14 Although the Library of the Kaivalyadhāma is not adequately equipped to-day, the stock of books in it is sufficient to meet the needs of the probationers. It is intended to develop the Library as soon as possible, so that the probationers at the Academy will have no difficulty in connection with their advanced studies.

15 The Reading Room maintained by the Ās'rama is excellent and the probationers at the Academy can take full advantage of the same.

16 Comfortable hostel arrangements are provided for the probationers at the Academy either at Pātan'jala Vihāra or outside it, according to the needs of the probationers.

MISCELLANEOUS

17 In order to give practical training in the different activities of the Ās'rama, probationers are made to take part in the management of the different departments of the Kaivalyadhāma. The burden of work, however, is kept within proper limits and is not allowed seriously to interfere with their progress at the Academy.

18 With a view to avoid development of eccentricity due to isolation, probationers are brought in close contact with men of light and leading that always visit the Ās'rama. Lectures on different spiritual topics are arranged and are followed by discussions between the speaker and the probationers.

19 The Academy is situated in a place ideally suited for spiritual work. It stands in the midst of the Sāhya mountains at the foot of a hill. The surrounding scenery is grand and inspiring. Being within a mile and a quarter from the Railway Station and the Post and Telegraph Offices, the probationers at the Academy can keep themselves in touch with the modern life and civilization. The rich Reading Room brings them the daily news from the different parts of the world.

20 Probationers are admitted to the Academy every second year. The first batch was admitted on the 6th of January 1929, when the Academy was founded. The next admission will be made in January 1931.

21 At present there are six probationers at the Academy. One is an M. Sc., another a B. Sc., and the remaining are undergraduates.

22 Instruction at the Academy is given free of charge. The probationers are boarded and lodged at the expense of the Ās'rama which is also responsible for meeting their other needs as probationers.

SHORT COURSE

for

VILLAGE SERVICE

NOTE—

The details of the Short Course have not yet been worked out. The following items are being published simply with a view to convey a rough idea as to what the course is going to be.

1 The Short Course will extend over three years.

2 The following subjects will be taught in this Short Course.

- i Practical knowledge of Yoga.
- ii Studies in the devotional literature of the province.
- iii Elements of Agriculture, theoretical and practical.
- iv Elementary knowledge of Dairy and Cattle Breeding.
- v Theoretical and practical knowledge of Spinning and Weaving.
- vi An extremely elementary working knowledge of Āyurveda.
- vii Village Sanitation.
- viii Village Economics.

THE STAFF OF THE ACADEMY

KULAPATI

S'rīmat Kuvalayānanda,
Tutor in

(*i*) Theory and Practice of Yogic Spiritual Culture.
(*ii*) Theory and Practice of Yogic Therapy.
(*iii*) Theory and Practice of Yogic Physical Culture.
(*iv*) Theory of Non-Yogic Physical Culture.

SUPERINTENDENT

Dr. V. D. Merchant, L. M. S., Retd. Civil Surgeon (British India),
Tutor in

(*i*) Elements of Physiology.
(*ii*) Elements of Hygiene.

TUTORS

Dr. B. M. Kadkol, M. B., B. S., Bacteriologist & Ophthalmologist,
Tutor in

(*i*) Elementary Anatomy.
(*ii*) Clinical Methods.

S'rīyuta Raghunāthashāstrī Kokaje, Tarka-Tīrtha,
Tutor in

Āryan Philosophy.

Prof. S. V. Dandekar, M. A.,
Tutor in

Western Philosophy.

Vacant
Tutor in

(*i*) Economics.
(*ii*) Constitutional History.

RUGṆA - SEVĀ - MANDIRA

RULES AND REGULATIONS FOR PATIENTS

1 The Sevā-Mandira is a part of the Kaivalyadhāma. It is established with a view to find for the inmates of the Ās'rama an opportunity to serve ailing humanity. It is desirable, therefore, that every gentleman coming to the Sevā-Mandira should, as far as possible, conform to the discipline of this place. No unholy act or word should disturb the peace of the Ās'rama.

2 The Sevā-Mandira is strictly for vegetarianism. No non-vegetarian food or tonic would be allowed within the limits of the Sevā-Mandira.

3 Tea and smoking are entirely prohibited within the precincts of the institution.

4 All Yogic treatment and consultation is given gratis.

5 The Sevā-Mandira undertakes to treat only chronic patients who are not confined to bed. If, however, any acute symptoms develop after a patient is admitted to the Sevā-Mandira, he will get competent medical advice and attendance quite gratis, but will have to pay a moderate charge for the treatment he receives.

6 To avoid inconvenience to himself and to the management of the Sevā-Mandira, it is desirable that an intending patient should send beforehand precise information regarding the time of his arrival and the probable period of his stay.

7 Every patient that comes to stay in the Sevā-Mandira even for a day is requested to have his own bedding.

8 Being a hill station, Lonavla is generally cool throughout the year. It is desirable, therefore, for every patient coming to the Sevā-Mandira to have sufficient warm clothing with him.

9 Boarding and lodging are given free of charge, for the first two days, to every patient coming to the Sevā-Mandira. Should any one overstay this period, he is charged at Rs. 45/- per month from the date of his arrival for his actual expenses. These charges should be paid in advance.

10 The concession for the first two days is general. Should a gentleman, however, wish to pay even for these days, the money will be thankfully accepted.

11 No concession can be allowed to anybody absenting himself from the Sevā-Mandira for a day or two. If, however, this period exceeds two days, he will be charged only eight annas per day for the period of his absence, provided he intimates the authorities beforehand.

12 The servants of the Sevā-Mandira look to the ordinary needs of a patient. Should any one want special menial attendance he must bring his own servant who will be charged for his actual expenses as well as his master.

13 Persons intending to leave the Sevā-Mandira should kindly intimate beforehand the time of their departure.

14 The Sevā-Mandira is being conducted with a religious sentiment. The management is, therefore, always anxious not to be mercenary. Gentlemen coming to the Sevā-Mandira are requested to appreciate this attitude and not to introduce any unpleasant monetary discussions in their dealings with the authorities.

15 The Sevā-Mandira stands for Yogic treatment and Yogic treatment alone. It is hoped, therefore, that the facilities given here will not be used for any other purpose by looking upon the institution either as a general sanatorium or health home.

16 As Lonavla records an average rainfall of 175 inches per year, practically all therapeutical work is suspended from the beginning of July to the middle of September. Patients are, therefore, requested not to venture an expedition to this place during the months noted above.

17 There is no accommodation for females. They may, however, come for a few hours for consultation and also for instruction if so advised.

18 People suffering from contagious, infectious or venereal diseases are not admitted to the Sevā-Mandira. For the last class of patients Yogic treatment is not available. Patients of the first two types can be treated as out-patients at the Ās'rama.

19 Indoor treatment is not compulsory for every patient that seeks relief through Yogic Therapy. Patients can make their own arrangements for boarding and lodging outside the Ās'rama and come for treatment as out patients. They are given the same facilities as the in-patients except medical attendance by the bed-side.

20 No separate cooking is allowed, nor is the Sevā-Mandira available exclusively for lodging.

21 Clinical work is done up to 11 a. m. Patients coming to the Sevā-Mandira later have to wait up to the next morning, for consultation.

NOTE--

Lonavla is a big railway station on the main line of the G. I. P. Railway running from Bombay to Poona some eighty miles away from the former. The Ās'rama is situated at a distance of a little more than a mile from the station. Conveyances are always available at the station by day-time. Should a stranger, however, wish to walk down the distance, he can very easily do it, first by inquiring for the Bombay-Poona Road and then by tracing the Ās'rama with the help of the signboards which are placed along the said road at convenient distances. Failure to succeed in this enterprise should direct the pedestrian to the local Post Office for more exact and detailed information.

Manager,
KAIVALYADHĀMA.

RULES AND REGULATIONS

for

VISITORS

1 Persons coming to the Ās'rama for purposes other than therapeutical are called *Visitors*.

2 All the rules and regulations applicable to patients hold good *mutatis mutandis* also for visitors, if they wish to stop at the Ās'rama for any length of time.

3 No fees are charged for Yogic Instruction.

4 All inquiries should first be made at the Yoga-Mīmāṅsā Office which will be working for supplying information up to 6 p. m.

5 Visitors are requested to get their business done during the office hours only. Prompt and business-like methods are recommended.

6 The Director should please always be approached through his Personal Secretary.

7 The Director is always hard pressed for want of time. Visitors are, therefore, requested to finish their business in the shortest time possible. No interview should exceed 15 minutes. In case a longer interview is desired, the visitor is requested to get through the Personal Secretary a special appointment with the Director for the time he wants.

Manager,

KAIVALYADHĀMA.

RANA NATAVARASINGH CLINICAL LABORATORY

This Laboratory was started in October 1926 and has been associated with the royal name of H. H. The Maharaja Rana Saheb of Porbandar, with his consent, out of gratitude for the patronage His Highness has been graciously giving to the Ās'rama. It is directly in the charge of the House Surgeon of the Ās'rama, Dr. B. M. Kadkol, M. B., B. S., Ophthalmologist and Bacteriologist. Physical, chemical and miscroscopic tests are instituted in this Laboratory and are offered gratis to everyone presenting himself for clinical examination,

Although this Laboratory is primarily meant for the indoor and outdoor patients of the Ās'rama, it has been thrown open to the general public, also free of charge. It is not binding upon persons presenting themselves for examination from outside to follow the Yogic treatment. They are free to place themselves under any medical man outside the Ās'rama for whatever treatment they like.

HOURS OF ATTENDANCE

8 A. M. To 11 A. M. **4 P. M. To 5 P. M.**

N. B.—Work during extra hours will be done only for very urgent cases.

Lonavla,
15-3-1930.

Kuvalayānanda,
DIRECTOR, KAIVALYADHĀMA.

THE KAIVALYADHĀMA

HOURS OF BUSINESS

Director's Office

8-30 A. M. To 11-30 A. M. 5-30 P. M. To 6-0 P. M.

House Surgeon's Office

8-0 A. M. To 11-0 A. M. 4-0 P. M. To 5-0 P. M.

Yoga-Mīmāṁsā Office

9-0 A. M. To 11-0 A. M. 1-0 P. M. To 4-0 P. M.

Demonstrator's Room

8-30 A. M. To 11-30 A. M.

Rana Natavarasingh Clinical Laboratory

8-0 A. M. To 11-0 A. M. 4-0 P. M. To 5-0 P. M.

Library*

12-30 P. M. To 1-30 P. M.

Reading Room

8-30 A. M. To 11-30 A. M. 1-0 P. M. To 6-0 P. M.

S'rīman Mādhava Yoga Mandira*

3-0 P. M. To 5-30 P. M.

Manager,

KAIVALYADHĀMA.

* On Thursdays this branch of the Ās'rama will remain closed.

THE KAIVALYADHĀMA OR THE INSTITUTE OF YOGA†

Excellent Field for the Service of Humanity

It is gradually being admitted by the leading men of science that the man as we perceive him is not the whole man, nor the phenomenal world, the whole of creation. The researches in the various branches of physical sciences have a tendency to push their inquiry into the world of subtler matter and finally to focus the search-light on one Supreme Object—the one Indivisible Essence, the ultimate cause and substance of all—that is found in the universe. Ever since the dawn of reason, man is ceaselessly trying to unravel the mystery of existence. In the West as well as in the East, men have persistently attempted to approach the transcendental Essence 'knowing which everything else becomes known'. But while the West struggles to make its quest on speculative lines, though of late it is exhibiting biological and physiological tendencies, the East has been, throughout its course, purely subjective and introspective. The Eastern philosophers have arrived at definite results of which the Westerners are dimly becoming conscious as they push their inquiry from one landmark to another.

Time has now come to bring the Eastern Yoga into the glare of Western physical sciences and to interpret its processes and results in the terms of objective sciences. Yoga may be roughly defined as the science and art of training and refining the inner and subtler perceptives of man, of awakening and controlling the unseen spiritual forces working in and through him, and with the aid of these refined perceptives and forces bringing him face to face with the ultimate substratum underlying the phenomenal existence. Thus the aim of Yoga from beginning to end is the realization of the sublimest in man, and probing to its farthest limits the nature of all life. In theory and practice it is essentially mental and spiritual, and even its apparently physical processes have their mental and spiritual bearing. Its uses in the line of physical culture and therapeutics are if anything but its bye-products.

AIMS OF THE INSTITUTE

The Kaivalyadhāma, as this institute of Yoga is called, proposes :—

(*i*) To carry the biological tendency of the Western philosophy to its logical conclusion by tackling scientifically the highest states of human experience.

† This and the next article originally appeared in the *Sunday Edition of the Bombay Chronicle* on 2-4-1929 and 21-7-1929 respectively.

(*ii*) To make the Western laboratory methods of research reveal spiritual wonders.

(*iii*) To develop the objective character of the Indian philosophy by subjecting the individual experiences of man to experimentation.

The Yoga philosophy is at least three thousand years old ; but it was first systematized by Patanjali (300 B. C.), and since then it has been enriched by other Yogins, who followed in his wake. By processes peculiarly their own, the Yogins were able to induce the highest spiritual stages. But those stages were not studied objectively and for the matter of that they merely recorded individual experiences. As the objective sciences had not developed till late, it was not possible for their experiences to be experimented upon; and though lately there has been a startling advance in modern sciences, their exclusive material tendencies and the equally exclusive spiritual tendency of the Yogins have led to a complete but unlucky divorce of the two schools of thought. The Kaivalyadhāma is anxious to wed these two together and produce results which will lead to the realization of the ideal indicated above.

SERVANTS OF HUMANITY

The task which this institute has taken upon itself is, indeed, very arduous. But from the scientific spirit in which it is carrying on its experiments for the last five years, it is not far from truth to predict that it is pregnant with immense possibilities. The Kaivalyadhāma has already attracted the attention of the savants of the West, though practically a fraction of its experimental work is placed before the reading public, and that too of an entirely physical character. The experiments on the astral and spiritual sides of Yoga have perhaps not yet reached the stage of being placed before the critical world. For that nothing that has not been thoroughly tested by the Western laboratory methods should be given out to the public, is the motto that governs the conduct of this institute. It has no doubt made a good beginning and if it carries on its work for some years more, it will, in all probability, open up new vistas of human knowledge and shed a flood of light on the ultimate destiny of the human race.

But experimentation in the practices of Yoga is only a part of its work. It endeavours to train students not merely in the science and practice of Yoga proper, but in order to thoroughly equip them to disseminate this knowledge, care is taken to ground them well in Occidental as well as Oriental philosophy, and also in anatomy, physiology, pathology and psychology, as a working knowledge of the last four is supposed to be necessary for understanding the rationale of Yoga. In 1929 two science graduates and four matriculates were admitted in the Academy of Yoga in the first batch,

a new batch having to be admitted every alternate year hereafter. The Director of this institute aims at turning out true Brahmins, in other words, true *servants* of humanity. The pledges which these Yoga students are required to take aptly remind us of the Rishis, who sacrificed themselves at the altar of Brahma-Vidya; the students being required to take the vows of lifelong chastity and poverty and of love and service to humanity. After the completion of their course of study which runs over four years preceded by a candidature of two years, they shall not only broadcast the knowledge they have acquired, but be prepared to render whatever service they can in all activities of life, and accept no remuneration except the satisfaction of discharging their duties. As a matter of fact this institute is a nursery for the future servants of humanity. Selfless young men who are thirsting for the service of their Motherland will do well to look upon this institution as their training school.

The Textual Research Department of this institution is in itself an attraction for the erudite scholar and is likely to provide him with lifelong work. Ancient Yogic texts are to be edited in the style and critical spirit of the modern philologists. To meet this end old manuscripts are to be studied, accurate readings are to be ascertained and critical notes are to be written. And as there are a good many text-books to be thus dealt with, there is enough scope in this department for a number of scholars having previous experience in research work.

REBIRTH OF KNOWLEDGE

But the grandest of all is the dream of welding together a band of intellectual and spiritual giants devoted to the noble cause of helping the progress of humanity in all its activities. They are to study the currents, under-currents and cross-currents of different civilizations with a view to divert them through proper channels, and to investigate thoroughly the noblest parts of all human institutions, and to take practical steps for realizing the highest ideals of man in his different activities.

The human race is at present suffering from the throes of re-birth. New ideas and aspirations are sweeping aside old ideals and institutions. All that we have inherited from the past is in a crucible. And if India is to prove true to her noble heritage, she must proclaim the *truth*, the legacy of her ancient seers, boldly to the whole world. Swāmi Vivekānanda had cherished a dream somewhat akin to this but bolder by far is the dream of the Kaivalyadhāma, which is all-comprehensive and all-embracing. For the materialization of this dream it calls for a band of young intellectuals, who would devote themselves to this cause as did the immediate followers of Lord Buddha. Young men of India! Would you respond to this call?

One would naturally wish that the munificent public should lend their material support to this laudable work. To the Director of the institute we should suggest that though Lonavla is preeminently suited for a work of this nature, it may not be unwise to establish a branch in any one of the suburbs of Bombay in order to make it accessible to a greater number of people, and especially looking to the aforementioned intellectual work, Bombay, being a University town, will prove by far more suitable than secluded Lonavla, where the institute is at present located.

THE MĀDHAVADĀSA ACADEMY OF SPIRITUAL CULTURE

IN my previous article, I made a brief reference to the educational and research work undertaken by this institute of Yoga. Among the manifold activities of the Kaivalyadhāma, the establishment of the Academy of Spiritual Culture is one; and in the present article I propose to depict at some length the main features of this unique institution. Had I not been struck by its uniqueness both in its conception and execution, I should not have cared to draw the attention of the public.

The Academy is named after Shriman Mādhavadāsa, or more popularly known in some parts of Gujarat as Paramahansa Mādhavadāsa, who was the spiritual instructor of Mr. Gune, the present Director of this institute. It was from this Yogin that Mr. Gune learnt the processes of Yoga, and one of his present activities is to test and vindicate the truth underlying these processes by co-ordinating them with the modern physical sciences.

ITS GUIDING PRINCIPLE

In a way, this Academy is a sort of collegiate research institute, but it does not aim merely at specialization in any particular branch of knowledge. Though it recognizes the need and worth of specialization, it never loses sight of the important fact that the isolated study of any subject, is not only bound to be narrow in its outlook but is rarely very fruitful, especially if we judge its worth from its contribution to the sum total of human happiness. Hence this Academy lays down as its guiding principle that human sciences should be taught in a co-ordinate manner, not merely for their educative value but with a view to make them subservient to the pursuit of knowledge conducing to human happiness. I shall, therefore, dwell at some length on the variety of subjects taught at this Academy and on the cumulative effect which their study is sought to bring about.

THE YOGA PHILOSOPHY

Patanjali, as the reader knows, is the accredited founder of the Yogic science, whose views are embodied in his work known as the Yogadarshana. This work contains not only the psychological and spiritual aspects of Yoga, but lays down certain well-defined views on philosophy, which mark it out from the other philosophical systems of India. It must be, however, borne in mind that this Academy, though it accepts the psychological basis of Patanjali's Yogadarshana, does not stand for all that is connoted by his Yoga philosophy. If by philosophy is meant the rational solution of the riddles of

life, and inquiry into the ultimate destiny of soul, this Academy, broadly speaking, owes its allegiance to the absolute Monism of Shankara. But Patanjali's system of philosophy, though it differs from the other systems, can be best studied along with the rest, for all of them are in a way correlated. It is, therefore, deemed necessary that the students of this Academy should make themselves acquainted with the principal heterdox as well as orthodox systems of philosophy. In India, philosophy was and is never studied merely for its academic value; and its solutions of the problems of life did not interest the intellectuals alone, but were eagerly swallowed by masses, who strove to mould their lives according to them.

STUDY IN THE ACADEMY

Thus it came about that the philosophers in India were also the religious heads, and their philosophy served as the basis of their religious tenets. And it is interesting that though everyone of them has his own philosophy and his own theory of attaining perfection, most of them have unanimously accepted the psychological aspects of prayer and meditation. If we carry our research further and analyse the religious experiences of the Christian and Islamic saints and mystics, we shall very probably find them accepting the psychology of Patanjali for all practical purposes. Hence the study of Patanjali in correlation with the Indian and the non-Indian systems of thought and religious practices, is of supreme importance to one who desires to make a comprehensive study of the whole philosophical and religious output. It is also laid down that the students of the Academy shall be called upon to study the history of European philosophies and the works of the epoch-making thinkers of the West in some detail. As the modern European philosophy has a strong biological and psychological bent, the study of biology and human psychology shall always occupy an important place in their studies. Thus equipped the students shall undertake a comparative study of the religious experiences of the Christian and Islamic mystics. This study, undertaken in a critical but sympathetic spirit, will undoubtedly serve to wear away their angularities, if there be any, and endow them with catholicity so necessary for discerning all that is best in the religious experiences of the saints of other nationalities.

But this naturally leads us to one categorically essential condition required of all advanced students of Yoga, and that is the unfoldment and purification of their inner perceptives, and their capacity of projecting their consciousness in planes far above those of gross senses. Unless they fulfill this condition by persistent practices of the esoteric side of Yoga, all their book knowledge, however thorough, will be of no avail. Their inability to fulfil this condition will, for all times, remain a bar to their admission in the higher activities of this institute.

THE WELL DEVELOPED YOGIN

As I have mentioned in my previous article, the students of this Academy are not intended to develope themselves into mere Yogins, who shut themselves up in their self-centred bliss, but it is expected of them to serve humanity in all its activities. Participation in practical politics is the only function which the students of this institute are not supposed to undertake. But even then the study of politics is not eschewed from their programme. As the function of a well developed Yogin is to harmonize the various forces working for the good or ill of the human race, and if possible to evolve order out of chaos, it shall be a part of his duties to make a careful study of politics, sociology and economics in general. Therefore the study of the constitutional history of all the leading nations and also the study of economics and social sciences, are included in the curricula of this institute. Over and above this it is contemplated that the study of economics is to be undertaken from the particular view point of Indian economics in a manner to offer solution of India's economical problems from the spiritual aspects of life.

ANATOMY AND PHYSIOLOGY

The unfoldment of the inner perceptives, above hinted at, can be diverted to another equally important field of research work. Our present knowledge of anatomy and physiology is by no means complete. There are a good many functions of the human body whose secrets and inter-relations have not been fully disclosed by the modern instruments of research and have baffled the keenest laboratory investigations. The advanced students of Yoga with a working knowledge of anatomy and physiology, coupled with their capacity of carrying on their researches far beyond the realms of X-Ray and microscope, are very likely to bring to light yet unknown mysteries of the human body. With this end in view arrangements have been made to impart instruction in these sciences under capable tutors, and a physiological as well as an anatomical laboratory is equipped with apparatus, anatomical parts, models, charts, etc. The ancient masters of Yogic science have in their works dwelt upon the therapeutical side of Yoga ; and the Yogins are reputed to possess the power of healing diseases without the use of drugs. The preliminary physical processes which every student of Hatha Yoga has to master, can be very well made use of in the way of curing diseases. It is for the modern student of Yoga to study these processes in the light of physical sciences, and determine the number and nature of diseases which can be brought under control by the aforesaid Yogic processes. A serious attempt is being made by this institution to awaken interest of the students in this important branch of study. It possesses a laboratory for the clinical tests and examination of the various pathological conditions ; and has provided for the theoretical and practical instruction in the clinical tests

under two medical graduates of the Bombay University. When the students shall have sufficiently advanced in their studies on the physical side, the Director of this institute, who has taken special pains to bring the knowledge of the physical sciences to bear on Yogic Therapeutics, will conduct classes in this subject. For practical training of the students at the bedside, there is provision made by starting a Yogic Health Resort where patients come from all parts of India to be treated by the Yogic methods. After the completion of their study they are supposed to take up either or all of the following activities:—

(*i*) To carry on research work in human anatomy and physiology.

(*ii*) To impart instruction in Yoga and incidently in physical culture.

(*iii*) To make practical use of their knowledge of the Yogic Therapy.

A thorough grounding in modern anatomy, physiology and pathology thus forms a necessary part of their equipment. Over and above this one more arduous duty devolves upon them. It is to harmonize the apparently conflicting theories of the ancient and modern Yogic and Non-Yogic philosophies and make them complementary of each other.

THE IDEAL IN VIEW

Thus it will be seen that this Academy combines all the features of a collegiate research institute with the spiritual halo of the hermitage of the ancient Rishis. In the ideals which the institute is closely pursuing, we notice the happy blending of all that is best in the religious or quasi-religious institutions of the East and the West; and to crown all, the ideal of rendering service to humanity to the utmost capacity, is steadily kept in view. The institute is at present in its infancy. The rich fruits it is likely to bear, are hidden in the womb of the future. It is, therefore, extremely hazardous to predict what miracles it will hereafter accomplish. But even as it is, it is bound to evoke the admiration of all who are interested in the all-round progress of the human race. Its ultimate success rests in a large measure on the type of students and workers it draws to itself; and it shall remain a matter of humiliation and regret, if some of the best products of Indian universities de found wanting in the necessary self-sacrifics and devotion to the search after *truth*, for these two qualities are all that is required of its students, besides sound physique. No other institution in the world is known to hold forth so brilliant a prospect of harmonious, physical, intellectual and spiritual development; and it is earnestly hoped that the younger generation shall avail themselves of this Yogic institution.

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* This paragraph cancels the dates stated in the *Editorial Notes* on p. 165 which was printed before the Press trouble arose.